Acknowledgements

This is the end of a long but very rewarding journey into the heart of academia. Looking back at the path that led me here, I feel indebted to a number of individuals and institutions who have played a key role in this journey. Hence, I would like to express my gratitude to them as without their help and support, it would not have been possible to stand where I am standing now.

First of all, I would like to thank Professor Bo-Göran Ekholm, my degree supervisor and Professor Jan Wallin, my thesis supervisor. I appreciate the time and effort you have put into supervising me. Your constant feedback helped me to stay on the right track and I have learnt a lot from the countless discussions we had.

I am also very grateful to my pre-examiners, Professor Prabir Bagchi from the George Washington University, who was also my opponent and Professor Joel Wisner from the University of Nevada, Las Vegas. Their valuable comments helped improve the dissertation. I am also grateful to Joel Wisner for reviewing the language.

From the Department of Accounting, I would like to thank Professor Anders Tallberg who encouraged me to undertake this project. In the beginning, I had some great discussions with him on the topic, which helped me to get started. I would also like to thank my colleague Oana Velcu for her feedback during the seminars and Monica Stark for helping me with some practical issues.

I would like to express my gratitude to two sponsors, the Hanken and Hans Bang Foundations. Their financial support has helped me to stay focused on the research.

Finally, I would like to thank my wife Tuuli and my parents for believing in me and for supporting me during these years.

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Helsinki, April 2008

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1 Introduction

1.1 The diminishing boundaries of the firm

The economic environment of today can be characterized as highly dynamic and competitive if not being in a constant flux. Globalization and the Information Technology (IT) revolution are perhaps the main contributing factors to this observation. While companies have to some extent adapted to the current business environment, new pressures such as the recent increase in environmental awareness and its likely effects on regulations are underway. Hence, in the light of market and competitive pressures, companies must constantly evaluate and if necessary update their strategies to sustain and increase the value they create for shareholders (Hunt and Morgan, 1995; Christopher and Towill, 2002). One way to create greater value is to become more efficient in producing and delivering goods and services to customers, which can lead to a strategy known as cost leadership (Porter, 1980). Even though Porter (1996) notes that in the long run cost leadership may not be a sufficient strategy for competitive advantage, operational efficiency is certainly necessary and should therefore be on the agenda of every company.

Better workflow management, technology, and resource utilization can lead to greater internal operational efficiency, which explains why, for example, many companies have recently adopted Enterprise Resource Planning (ERP) Systems: integrated softwares that streamline business processes. However, as today more and more companies are approaching internal operational excellence, the focus for finding inefficiencies and cost saving opportunities is moving beyond the boundaries of the firm. Today many firms in the supply chain are engaging in collaborative relationships with customers, suppliers, and third parties (services) in an attempt to cut down on costs related to for example, inventory, production, as well as to facilitate synergies. Thus, recent years have witnessed fluidity and blurring regarding organizational boundaries (Coad and Cullen, 2006).

The Information Technology (IT) revolution of the late 1990's has played an important role in bringing organizations closer together. In their efforts to become more efficient, companies first integrated their information systems to speed up transactions such as ordering and billing. Later collaboration on a multidimensional scale including logistics, production, and Research & Development became evident as companies expected substantial benefits from collaboration. However, one could also argue that the recent popularity of the concepts falling under Supply Chain Management (SCM) such as Vendor Managed Inventory, Collaborative Planning, Replenishment, and Forecasting owe to the marketing efforts of software vendors and consultants who provide these solutions. Nevertheless, reports from professional organizations as well as academia indicate that the trend towards interorganizational collaboration is gaining wider ground. For example, the ARC Advisory Group, a research organization on supply chain solutions, estimated that the market for SCM, which includes various kinds of collaboration tools and related services, is going to grow at an annual rate of 7.4% during the years 2004-2008, reaching to $7.4 billion in 2008 (Engineeringtalk 2004).

1.2 The Firm and its environment

Firms are not stand alone entities but are linked to their environment, i.e. to other individuals and companies along the supply chain in various ways: either by the market mechanism at arm's length or through more complex relations such as long-term contracting, reciprocal trading or franchising – in short, hybrids as Williamson (1991) calls them. A supply chain can be defined as "a network of manufacturers and service providers that work together to convert and move the goods from the raw materials stage through to the end user" (Bozarth and Handfield 2005:4). What determines the structure of companies and therefore supply chains is the interaction of various internal and external forces such as technological capabilities and supplier characteristics, where companies strive to find the optimum way to organize themselves. Hence for a company, it is the interplay of many factors that determine, for example, the make-or-buy decision, core competencies, and the type of relationship to pursue with suppliers and customers. Transaction cost economics offers some insight into the workings of

firm dynamics and provides an explanation for micro level phenomena such as firm size and supply chain structure (e.g. the degree of vertical integration) through the existence of so-called transaction costs (Coase, 1937). Thus, if firms can influence transaction costs by changing the way they interact with their environment, that is with their suppliers and customers, they can improve their efficiency and maintain their competitive advantage.

The resource-based view (RBV) of the firm provides an alternative lens and emphasizes the unique resources a company must possess to create and sustain its competitive advantage. Resources in the traditional sense refer to land, labor, and capital, but they can include intangible assets as well. Examples of intangible resources include among others, trade contracts (Wernerfelt, 1984) and customer relations (Hofer and Schendel, 1978). Thus, according to RBV, the relationship of a company with its external environment can be a source for competitive advantage.

Coleman (1988) illustrates the importance of external relations for competitive advantage, not only in the context of supply chains but more generally. Coleman (1988) defines three types of capital that make up the total capital of a company: physical capital, human capital and social capital. Physical capital refers to the tangible assets of a company such as buildings, machinery, and inventory. Physical capital is relatively easy to measure and has been the subject of analysis in traditional economics and accounting. Human capital refers to the characteristics of the people employed in the company such as personal knowledge and education. The third form of capital is social capital and includes the social relations of people within the company, as well as the relations with persons outside the company who represent other companies. The values of human and social capital as intangible assets are much harder to estimate. The interplay of physical, human, and social capital creates new capital and managers have to focus on these to secure company growth (Jakobsen, 2005).

Burt (1992 and 1997) argues that it is the social capital of a company that activates physical and human capital. According to Burt (1992), only companies operating in perfectly competitive markets do not depend on social capital because these companies

act on objective information that is, price and quality. However in an imperfect market, which is the market situation for most companies, the ability of a company to effectively interact with relevant partners will influence the profitability of the entire capital and therefore the economic performance of the company. This is well exemplified by firms such as Wal-Mart, Toyota, and Dell, who have used their supply chains as strategic weapons to gain advantages over their peers (Ketchen and Hult, 2006).

1.3 Description of the problem area

Collaboration in one form or the other entails the exchange of private company information (e.g. marketing plans, demand forecasts, inventory levels) between the collaborating companies. This information can then be used, among other things, to optimize purchasing, inventory, capacity, and production planning activities. Also, joint product development through the exchange of design information and know-how can help reduce development and supply chain related costs. Hence, the sharing of private information can help companies support their strategy, which is typically characterized as cost leadership or differentiation (Porter, 1980). The two strategies are not mutually exclusive and companies today also pursue them simultaneously (Bask and Juga, 2001). Apart from efficiency gains, information sharing can also lead to a reduction in business risk. For example, better sales forecasts through joint sales forecasts can allow a company to optimize operational leverage. Furthermore, in the long run, the company can also optimize financial leverage, which results in lower earnings variability and hence lower business risk.

Information sharing can also lead to more risk, as the risk of opportunism and preemption increases with the level of transparency between firms. The nature of the risks are different (the latter being one-off) and companies that have the differentiation/focusing strategy might be more at risk, although the technology and know-how for operational efficiency must also be protected. In effect companies can gain competitive advantage by reducing costs and risk through information sharing and

therefore get a higher rate of return on capital given that the firm can capture a part of the additional value created. However, companies will only consider sharing sensitive information with external parties when the risk of opportunism is not too high, that is in theory up to the point where the marginal benefit of sharing information equals the marginal cost of information sharing. Having said that, in practice this kind of cost – benefit analysis is hard to carry out, as the quantification of the elements are likely to pose a big challenge to the company. Despite its risks, more transparent supply chains are emerging, where companies not only exchange operational data but also increasingly share strategic and proprietary information to gain competitive advantage in their industries.

The scientific literature in this field (mainly buyer-supplier integration, logistics, Supply Chain Management) provides support that it pays for a focal company (the subject of interest in a study) to share information in the supply chain. For example, there is evidence on performance improvements regarding inventory levels (Bagchi and Skjoett-Larsen, 2005; Cassivi et al., 2004), supplier deliveries (Bagchi and Skjoett-Larsen, 2005; Petersen et al., 2005; Cassivi et al. 2004), competitiveness (Li et al., 2006), and product development costs (Perona and Saccani, 2002) as a result of collaboration. These findings support the conventional wisdom in supply chain literature that the more integration there is, the better the performance (Bagchi and Skjoett-Larsen, 2005). Despite this view, companies have been somewhat slow and hesitant to adopt supply chain practices and technologies that support them (Bagchi and Skjoett-Larsen 2005; Bagchi et al., 2007; Kemppainen and Vepsäläinen, 2003). This can be perhaps explained through the existence of a different view – that companies should go for limited or selective collaboration as “the risk is growing that integrated systems and processes across the supply chains are obsolete once they have been created” (Bask and Juga 2001:149). Yet Bask and Juga (2001) note that even if channels are increasingly separated by, for example, outsourcing the sales or payment functions, they must be orchestrated, which requires transparency and connectivity between companies.

Considering how much interfirm collaboration as a topic has attracted attention from academia and practice recently, it seems that transparency and information sharing is a

striking characteristic of the 21st century supply chain. As explained before, information sharing can help companies achieve their objectives, which is primarily to maximize shareholder value. Thus, if information sharing is so critical in the supply chain, then it raises the question: What factors determine information sharing between companies? This is an important question if individual companies in the supply chain are required to act together to optimize the supply chain as a whole, which is the basic idea behind supply chain management. For this to happen, one must focus on each link (supplier-customer pair) in the supply chain so as to be able to develop measures that encourage information sharing between companies. Once the barriers to information sharing are eliminated, mechanisms towards optimizing the entire supply chain as opposed to each link can be developed. This is well illustrated by Douglas and Pohlen (2001), where first each link in the supply chain is optimized and then adjusted to optimize the entire supply chain, often at the expense of one or several companies. As mentioned before, for this to work, companies must be first willing to share information at the dyadic (company-to-company) level.

Although there is some indication on what factors might influence the decision of companies to share information with, for example, a key supplier (other than financial costs), there is lack of empirical evidence. As collaboration in one form or the other requires the exchange of proprietary information, the role of trust (as a counterforce to risk), which has been extensively studied in interorganizational relationships (e.g. Neuman and Samuels, 1996; Hart and Saunders 1997; Petersen et al., 2005), cannot be neglected. Furthermore, power has also been identified as a factor that affects supply chain relations (e.g. Hart and Saunders, 1997; Webster, 1995). However, trust and power cannot be the only determining factors of information sharing and other factors might have an equally important role. Despite the popularity of collaboration and SCM in the academic literature, knowledge in this field is rather limited. There is little empirical evidence why certain firms collaborate and share information with their suppliers and customers more intensely than others even though the merits of collaboration are obvious.

1.4 The scientific aim of the research

There is an extant literature on supply chains that focuses on performance improvements companies can achieve through information sharing. Although, the argument in favor of information sharing in the supply chain appears to be strong, there are differences in companies' efforts to share information. Thus, the aim of this research is to explain (i) why differences in the intensity of information shared between buyers (the focal firm) and their key suppliers exist and (ii) how this affects focal firms' performance. Drawing from mainly transaction cost economics, the contingent factors identified herein are used to develop a model, which is tested with empirical data. The study investigates this phenomenon under the recent effects of the IT revolution.

1.5 Theoretical approach of the study

The motivation for companies to share information was discussed in Section 1.3. Information sharing between a buyer and supplier can reduce costs and hence create more shareholder value. If this is true than we should observe all companies sharing as much information as possible. However, as mentioned previously, this has not been observed. To gain more insight into the subject, it might be useful to refer to contingency theory. Contingency theory accounts for various factors that might affect the developments of the internal features of an organization and can therefore provide some insight into the level of information shared between a focal company and its key suppliers. Hence, this study applies contingency theory logic once the relevant factors are identified from theory.

Contingency theory is closely related to organizational theory. According to Otley (1984), contingency theory is an element of organizational theory, as are for example, systems theory, and behavioral decision theory. Organizational theory as an approach has been widely used in management accounting. This kind of research seeks to identify relationships between environmental, organizational, behavioral, and accounting variables. Often, researchers who adopt this approach use cross-sectional studies in

which measures of the relevant variables are obtained by mail or interview-based questionnaires. Conclusions are then based on statistical analyses that are used to identify significant relationships between variables (Ryan, Scapens, Theobald, 2002).

Research that investigates the relationship between environmental and organizational variables such as contingency theory has its origins in the pioneering studies of Woodward (1958) and Burns and Stalker (1961). Throughout the years, organizational researchers have studied the impact of environmental factors such as technology, uncertainty, and complexity on organizational design variables such as structure, decentralization, and task complexity. Accounting researchers continue adding to the variables studied. In this vein, information sharing could also be regarded as an organizational design variable. Researchers have also attempted to identify relationships between environmental variables and accounting variables as well as between organizational design variables and accounting variables (Ryan et al., 2002). The accounting variables used in the studies include the accounting techniques or procedures used, e.g. the use of planning models and budgeting techniques or the complexity of organizational information systems. In these types of studies, researchers try to identify patterns that repeat consistently over a sample of organizations so as to make generalizations of results. However, as in every scientific method, this approach has some weaknesses, which are discussed in the next section on the assumptions of the thesis.

1.6 Ontological, epistemological and methodological assumptions

Objectivity is an important element in this research. In the pursuit of the research objectives, the goal is to capture the reality that exists independently of one's own perception. Thus from the point of ontology, the realist position is adopted. Taking the realist position, it is acknowledged that one can fall victim to incorrect reification by treating unobservables as observables. However it is believed that unobservables are appropriate for theory construction. The fact that scientific realism embraces fallibilism and critical pluralism and that it considers all knowledge claims to be tentative, makes it

a reasonable research positioning. Furthermore, the concept of probability in scientific realism is a good argument against the postmodernist view that it is impossible to know for sure whether knowledge claims are free of cultural, linguistic, or ideological bias (Westwood and Clegg, 2003).

The subject of this research is information sharing between organizations. Thus the human element unlike in natural sciences is very strong. In fact, it is the particular interaction of individuals that form organizations. However, when we think of organizations, one should bear in mind that they are not simply the sum of individuals that constitute them. This is the view of methodological individualism (MI), which claims in its first thesis that all social behavior consists of individuals and their behavior (Little, 1991). The second thesis of MI, on meaning claims that social phenomenon such as inflation is only definable by concepts that refer to individuals and their relations and behavior. The MI thesis on explanation contends that all social concepts must be explainable by the facts of individuals – their motives, powers, beliefs, and capacities. Even though, the first thesis is obviously true, the second and third theses on meaning and explanation in MI are not persuasive (Little, 1991). It is believed that there are so called emergent properties that do not exist at lower levels. This will be discussed further when the epistemological positioning of this research is presented.

As opposed to postmodernists, organizations are assumed to be real, that is, they are not invoked texts or linguistic creation (Westwood and Clegg, 2003). However, it is acknowledged that they are constantly changing and thus the reality about them. Individuals who form organizations are intelligent and are much harder to understand and predict when compared to for example, atoms. Atoms are subject to relatively few laws and causalities. Human behavior however is affected by a very large number of variables relating to the individual and society such as one’s own character, culture, and even regulations of the state in which he or she resides. These variables are interrelated and subject to autocatalysis. It becomes even more complex when collective behavior is to be understood or explained as in the case of organizations. This complexity poses the biggest challenge to the researcher in social sciences. Therefore, due to the complexity and dynamism of organizations, the reality is likely to change very often.

Epistemologically and methodologically, this research represents a typical positivist empiricist and nomothetic approach, which commonly uses inferential statistics and hypothesis testing. However, it should be mentioned that the approach here was far from the philosophical positioning of logical positivism treating unobservables as metaphysics. This approach was similar to what Donaldson (1985) described. According to Donaldson (1985), positivism aims for theoretical generalizations of broad scope, explaining social phenomena as being determined by causes of an objective kind that lie in the situation rather than in the minds of people. This study embraced the view that "there are often unanticipated consequences of social action, so that what organizations do cannot be determined by what their individual members know or think" (Donaldson 1985:115). This, as mentioned before, contrasts with MI. The importance of this issue is demonstrated with an example by Westwood and Clegg (2003) where an organization is threatened by foreign competition but its managers are not able to perceive or identify the threat even though the organization must adapt or die.

On the other hand, because every organization and the individuals that form it is unique (there is a small likelihood that the magnitude and combination of all variables are identical), results and findings may not always be as generalizable as in natural sciences. Nevertheless, high-level phenomena are subject to regularities and causalities without necessarily having to know the underlying phenomena at micro level, unlike in reductionism. Even though, variables may be different at micro level, extensive testing of data can lead to results and conclusions at a higher level. Thus, a positivist methodological approach can create novel knowledge that may not be possible through, for example, the interpretivist approach.

A drawback of statistical generalizations is that it does not exclude the possibility of exceptions. This becomes problematic when, for example, designing an accounting system that is compatible with the characteristics of the organization. Should the designer go with the general trend as put forward by statistical generalizations or should it be a design of exception (Ryan et al., 2002)? Thus, the purpose of this methodology is not to explain the processes through which different management practices evolve but to

predict general trends. Explanations of the former type are provided by longitudinal and process studies.

1.7 Positioning and scope of the study

There is an extensive body of literature that focuses on information exchange between companies in the supply chain, which fall within one or several interorganizational relationship typologies identified below (Hall, 1999):

- dyadic relationships (one to one relationships)
- interorganizational sets (one to many relationships)
- interorganizational network (many to many relationships)

Elgarah et al. (2005) reviewed 68 (1993-2002) articles from 34 journals on data exchange and found that nearly half of the studies (47%) adopted a dyadic framework whereas sets and network accounts for 31% and 22% respectively. According to Lincoln and Guillot (2003), “dyad and network represent alternative frames of reference and levels of analysis for the assessment of cooperative interfirm relations”. Transaction cost views the pair in isolation from the network in which it is embedded.

Interorganizational relationships from the dyadic perspective focus on relationships between just two organizations (Elgarah et al., 2005). For example, Perona and Saccani (2004) adopt a dyadic approach, where integration techniques between buyers and suppliers are examined. In interorganizational sets, the focus is placed on a focal firm and all its dyadic relationships with other organizations. Some authors have also embraced the network perspective. Jarillo (1988) defines strategic networks as long-term, purposeful arrangements among organizations to achieve long-term sustainable competitive advantage. For example, Straub and Klein (2004) take this approach and measure supply chain performance at the network level. As for this research, the dyadic view was adopted for the following reason. It was considered to be more logical and

fruitful to understand dyadic relationships better before moving on to networks, which are in their nature much more complex.

There seems to be some confusion about the usage of the terms describing different forms of collaboration between companies. Terms such as integration, cooperation and collaboration are often used interchangeably. Some explanation would therefore be useful. The Webster Dictionary defines cooperation "as the association of persons for common benefit". For Spekman et al. (1998) cooperation is the first level of integration in the supply chain followed by co-ordination and collaboration. Integration itself refers to the level of goals, culture, and information shared with the other partner (Alter, 1999). Co-ordination in the words of (Spekman et al., 1998:55) is

> *"whereby both specified workflow and information is exchanged in a manner that permits JIT systems, EDI , and other mechanisms that attempt to make seamless many of the traditional linkages between and among trading parties*."

The unit of analysis for this thesis is information sharing as it is the essential element in all kinds of integration efforts. Thus, this study refers to information integration rather than integration as defined by Alter (1999). Information sharing and information integration refer to the same idea, although information integration indicates a much more advanced level of information sharing than the occasional exchange of information between companies. Nevertheless, the two terms will be used interchangeably in this study. Furthermore, the focus is on information sharing with specifically key suppliers as opposed to suppliers in general (non-key suppliers) or customers. Key suppliers are companies, which provide direct materials that go into the manufacturing of the products sold by the focal company. Non-key suppliers provide low value non-critical materials such as office supplies and are relatively easy to replace. Thus, it becomes the key supplier, with which a focal company has the interest to share information as savings from information sharing can be relatively substantial. Conversely, key customers from the point of the buyer are more important for the purpose of information sharing than regular customers. However, in this research the customer side is not directly studied in order to limit the scope of the study. Yet, since

the focal company is a customer of a key-supplier, the issues identified in this study will also be applicable to the interaction between the focal company and its customers.

1.8 The structure of the thesis

The thesis is structured as follows. Chapter 2 begins with a discussion on the critical role of environment in the strategic planning process of a firm. This chapter introduces the central concept of uncertainty and how it affects decision-making at different levels in the company. Furthermore, the impact of uncertainty on the various costs are also explored. Chapter 3 explicitly deals with information sharing in the context of supply chains. The chapter discusses why information sharing might be desirable and presents the main practices and mechanisms firms can use to collaborate with each other. In chapter 4, a number of hypotheses are developed using mainly transaction cost economics as the underlying theory. Also in this chapter is a conceptual model built on information sharing based on the developed hypotheses. Chapter 5 discusses the research method whereby the sample, the measurement instrument, and Partial Least Squares Modeling are presented. In chapter 6, the data is analyzed using factor analysis and partial least squares modeling. Chapter 7 concludes the thesis and suggests new avenues for research.

2 The Firm as Part of the Supply Chain

2.1 Introduction

To understand the motivation of companies to share information with each other, it is necessary to discuss how companies create and sustain competitive advantage. Competitive advantage requires a good strategy, which is formulated in relation to the external factors that a company faces. Thus, section 2.2 deals with various approaches and views on the firm and how it relates to its environment with respect to value creation. Apart from the role of environment in strategy making, this section also explains how companies execute strategy and can use social capital to their advantage. The next section (2.3) introduces uncertainty and risk, which arises due to various factors in the environment. The section continues with a discussion on the impact of uncertainty on decision-making, which is exemplified with the problem it causes in the production function. This section also shows how uncertainty affects the firm in terms of costs and risks. The chapter is concluded with Section 2.4.

2.2 Leveraging the supply chain for competitive advantage

In the classical view, competitive advantage was concerned with the choice regarding the markets in which a firm would compete (Stank, Davis, and Fugate 2005). Thus, companies would defend/extend market share in clearly defined segments and product performance attributes (Day 1994). However, in more recent times, competition is considered a war of movement where companies anticipate trends and respond swiftly to changes in customer needs (Stalk, Evans and Schulman 1992:62). Competitive advantage arises from the creation of superior competencies that are employed to create customer value and achieve cost and/or differentiation advantages, which result in market share and profitability performance (Barney, 1991; Coyne, 1986; Day and Wensley, 1988; Prahalad and Hamel, 1990). To sustain competitive advantage, firms need to set up barriers that make imitation difficult. Hence, firms must continually

invest in the sources of their competitive advantage, making this a long run cyclical process (Day and Wensley, 1988).

Porter (1991) distinguishes between two ways of creating competitive advantage: a firm's ability to perform interrelated activities at a collectively lower cost than competitors (cost leadership), or to perform some activities in unique ways (differentiation) that create end customer value. Activities internal to the value chain include production, marketing, and delivery as well as support activities, necessary to acquire and retain internal assets. By performing activities, a company creates tangible and intangible assets. Tangible assets include products, machines and capital goods. Intangible assets can be in the form of skills, organizational routines, and knowledge (Stank et al., 2005), which can be referred to as human capital (Coleman, 1988). Furthermore, when the activities of a company are linked with external parties, i.e. suppliers and customers, the basis for the competition via the value chain is created (Stank et al., 2005). Here, the traditional value chain concept as put forward by Porter (1985) has been extended to include the entire supply chain.

Regarding the difference between a value chain and a supply chain, it is subtle. The former focuses on the creation of value for the customer as activities are performed along the supply chain whereas the latter emphasizes the movement of the goods (the logistics aspect). The recent focus on the supply chain or the extended value chain has led some scholars to argue that there is now competition between supply chains as opposed to competition between companies (Boyer et al., 2005; Ketchen and Guinipero, 2004).

Porter's framework of competitive advantage provides an explanation for how companies compete in markets but it does not provide specific guidelines regarding how to manage activities to create competitive advantage (Stank et al., 2005). Hence, this is explored in the next section when strategic planning in the firm is discussed.

2.2.1 The role of the environment in strategic planning

To understand the process leading to competitive advantage and the role of environment within, one should look at the strategic planning process. A definition of strategic planning is that it "attempts to systematize the processes that enable an organization to attain its goals and objectives. There are five general steps in the strategic planning process: goal/objective setting, situation analysis, alternative consideration, implementation, and evaluation" (Crittenden and Crittenden, 2000:151). Although, what each step includes is somewhat obvious, it might be interesting to discuss the second step – situation analysis – to some extent. Situation analysis involves the assessment of the internal and external factors relevant to the firm. Whereas the importance of firm-specific internal factors was long recognized, external factors made an impact to strategic planning only after the 70's (Renfro and Morrison, 1982). This is when strategy makers increasingly found that emerging external issues often had a greater impact on the future of their organizations than any of the internal issues. The evaluation of the external factors is often referred to as environmental scanning (Aguilar, 1967). Environmental scanning often refers to the macroenvironment but might also include industry, competitor analysis, and consumer analysis. The macroenvironment includes factors related to the economy (e.g. economic growth, unemployment rate), government (e.g. political stability, export restrictions), law (e.g. wage laws, copyrights/patents), technology (efficiency of infrastructure, industrial productivity), ecology, socio-culture, suppliers, and stakeholders.

The strategic planning process revolves around the idea of creating and sustaining competitive advantage. The strategy – structure – performance (SSP) paradigm, which dominated the industrial organization field in the last quarter of the 20th century, provides a lens through which the nature of strategic planning can be viewed (Galunic and Eisenhardt, 1994). The main idea behind SSP paradigm is that a firm's strategy is created in consideration of external environmental factors (mainly suppliers and customers), which drives the organizational structure and processes (Galbraith and Nathanson, 1978; Miles and Snow, 1978). Firms with the right match of strategy and structure are expected to outperform firms that do not have the same degree of strategic

fit (Child, 1972; Galbraith and Kazanjian, 1986; Habib and Victor, 1991; Hoskisson, 1987; Lubatkin and Rogers, 1989; Miles and Snow, 1984,1978; Wolf and Egelhoff, 2002). To give an example, Rumelt (1974) found that companies that diversify into a related product line or business outperformed both the firms that diversified into unrelated businesses and vertically integrated firms with limited diversification options (Defee and Stank, 2005).

To gain additional insight into the strategic planning process of a company, the resource-based view (RBV) of the firm will offer further explanation. In the RBV of the firm, competitive advantage is generated through internal capabilities and resources rather than its product or service outputs (Barney, 1991; Wernerfelt, 1984). According to the RBV, companies attempt to identify and invest in those skills and activities that lead to most profitable capabilities and competencies (Day and Wensley, 1988). To explain what capabilities and competencies are, it is useful to quote from Stank et al. (2005:29)

> *"Capabilities are sets of processes or dynamic routines that reflect the way resources have been coordinated, deployed, and applied to the environment. Competencies are aggregates of numerous specific capabilities potentially spanning lines of business, organizational boundaries, groups, and/or individuals that a firm performs better than other firms within a similar environment."*

Regarding what constitutes resources of a firm, it is a disputed topic in the literature (Stank et al., 2005). Besides the tangible resources of a company, i.e. land, labor, and capital, intangible resources include among others, brand names, in-house knowledge of technology, skilled personnel, machinery, trade contracts, efficient procedures (Wernerfelt, 1984), customer relations (Hofer and Schendel, 1978), and supplier relations. These resources involve elements from both internal and external factors to the company.

SSP and RBV paradigms are complementary and give insight into the strategic choices of the firm at multiple levels, including corporate, strategic business units (SBU), and functions (Hofer and Schendel, 1978; van Hoek, Commandeur and Vos, 1998; Varadarajan and Jayachandran, 1999; Walker and Ruekert, 1987; Webster, 1992).

Through corporate strategy, the mission and vision of the firm is determined. This includes the lines of business in which the firm competes, the product groups developed, its growth strategies and financial objectives, and the commitments the firm makes to its stakeholders (Rao, Stenger, and Wu, 1994).

SBU strategy defines the orientation of the firm regarding the way it will compete and the type of core competencies it must develop at the functional level (Gatignon and Xuereb, 1997; Narver and Slater, 1990). Functional expertise refers to the amount and types of resources that a specific function will develop to create particular capabilities that contribute to core competence. The interaction of corporate strategy, SBU orientation, and the capabilities and competencies that create functional expertise determine the extent to which a particular business is able to achieve and sustain a competitive advantage (Varadarajan and Jayachandran, 1999).

As mentioned before, the SSP strategic planning paradigm argues that the strategic choice of a company is dependent on conditions regarding the external environment (Galbraith and Nathanson, 1978; Miles and Snow, 1978). To explain the strategic choices of the company, Porter's five forces framework can be used (Stank et al., 2005). According to Porter (1981), key environmental conditions, which include competitive rivalry, new entrants, customer and supplier bargaining power, and availability of substitute products, influence industry structure. Firms within different industries, will adopt different strategic orientations in response to the degree of environmental complexity and turbulence present. According to Achrol (1997), as business environments become more complex and turbulent, firms increasingly explore collaborative organizational structures and norms to gain efficiency and effectiveness.

2.2.2 Developing capabilities for supply chain orientation

More recently, environmental complexity and turbulence have attenuated Porter’s forces across industries in developed economies, encouraging collaborative behaviors (Aijo, 1996; Mentzer, Min, and Zacharia, 2000). The ever increasing global competition and

the availability of substitute products and services in industries such as automotive, electronics, and consumer durables and packaged goods have led to higher customer bargaining power, driving prices down and forcing a focus on cost and risk reduction. Under such circumstances, firms often seek to leverage the resources of other supply chain members to survive (Geoffrion and Powers, 1995). For example, original equipment manufacturers have linked their manufacturing and logistics processes with those of their suppliers using techniques such as Total Quality Management, Just-in-Time, and Vendor Managed Inventory to enable cost reduction and innovation (Bowersox, Mentzer, and Speh, 1995; Stock, Greis, and Kasarda, 1999). Furthermore, many firms have adopted practices such as Collaborative Planning, Forecasting, and Replenishment to improve supply chain planning. As a result of the increased focus on customers and suppliers, companies require tremendous levels of coordination and collaboration (Stank et al., 2005).

An orientation that has been widely discussed in the literature is supply chain orientation, defined as

> *"the recognition by a company of the systemic, strategic implications of the activities and processes involved in managing the various flows in a supply chain."* (Mentzer et al., 2001:14)

Supply chain orientation (SCO) can be compared to other orientations such as customer orientation, product orientation, and competitor orientation. SCO differs from other orientations by adopting "a systemic view stretching beyond the focal firm to include coordination of business processes and flows with those of other members of the supply chain for the purpose of creating a strategic advantage based on end-customer value delivery" (Mentzer et al., 2001:10).

An important element of RBV is that SCO orientation is implemented by investing resources in key capabilities that facilitate functional competence. Thus, when a firm determines that the development of internal logistics expertise is a key competence required to implement SCO, the desired structure of logistics is achieved by investing in capabilities concerning the move and store activities.

Logistics has emerged as an important capability especially in mature markets where commodity type competition forces businesses to seek alternative methods for differentiation. In markets where product quality and features do not differ significantly, a strategy that does not focus on product, price, and promotions must be found in order to achieve strategic goals Stank et al. (2005). Better logistics performance enables firms to add value to the service component of the product, which does not only attract new customers but retains existing ones. Hence, investment in resources to develop logistics capabilities has emerged as a key determinant of customer value as firms have realized that competing on "strong brands and a strong corporate image" are not enough; they must exploit logistical processes (Stank, Keller, and Closs, 2001).

Based on a literature review in logistics, Stank et al. (2005) identify the following broad categories of logistics capabilities: customer focus, time management, integration, information exchange, and evaluation. Each of these capabilities supports the goal of the company and is important for an efficient supply chain. These capabilities are briefly explained below, although information exchange will be further explored and discussed in Chapter 3 as it is the central element of the thesis.

Customer focus is an important capability, which has been widely discussed in the logistics literature (see, for example, Bowersox, Closs, and Stank, 1999; Lynch, Keller, and Ozment, 2000; Mentzer, Min, and Bobbitt, 2004; Morash, Dröge, and Vickery, 1996; Stank and Lackey, 1997; Zhao, Dröge, and Stank, 2001). Customer focus as a capability requires customers to be segmented based on certain characteristics such as demographics and purchase behavior. Once customers are segmented, product and/or service differentiation as well as their enhancement can be achieved by targeting a particular customer base. Through customer focus, the firm can better meet and exceed customer expectations by providing unique and value-added activities (Mentzer, Min, and Bobbitt, 2004), which can lead to more sales and shareholder value.

Another key logistics capability refers to the effective management of time to eliminate wasted capital (Daugherty and Pittman, 1995; Lowson, 2003; McGinnis and Kohn, 1993; Mentzer, Min, and Zacharia, 2000). Shortening the ordering cycle, which allows a firm to relatively quickly translate an order into a finished product and to deliver it, can

capture time-sensitive buyers better than competitors (McGinnis and Kohn, 1993; Murphy and Farris, 1993). Also reducing the time required for order processing allows businesses to better respond to demand fluctuations by reducing distortion to the order cycle process (Daugherty and Pittman, 1995; McGinnis and Kohn, 1990). Furthermore, postponement, modularization, and standardization are considered to be key time management techniques. Logistics postponement involves delaying the forward movement of goods as long as possible and storing goods at central locations within the supply chain (van Hoek et al., 1998). Modularization and/or standardization can create "a focused expertise with materials and processes to a point where it is much easier to identify sources of delay, unnecessary steps" and redundancies (Jayaram, Vickery, and Dröge, 2000).

Integration as a key logistics capability is a state when processes become interwoven and therefore hard to imitate (Daugherty, Stank, and Ellinger 1998). There is empirical evidence that (internal) integration of logistics has a positive affect on firm performance (Boyer, Hult, and Frohlich, 2003; Ellinger, Daugherty, and Keller, 2000; Kahn and Mentzer, 1996; Stank, Daugherty, and Ellinger, 1999). Elements of integration include cross-functional unification, structural adaptation, process standardization, simplification, and compliance (Bowersox, Closs, and Stank, 2003). According to Kahn and Mentzer (1996), internal integration is achieved through two fundamental components: interaction and collaboration. Interaction refers to the communication aspects associated with interdepartmental activities, whereas collaboration represents the attitude and willingness of departments to work together. External integration is equally important, where integration refers to the level of goals, culture, and information shared with the other partner (Alter, 1999). As external integration includes information sharing, the topic is further discussed in Chapter 3 on information sharing.

A further key logistics capability that enables improved firm performance is information exchange (e.g., Bowersox, Closs, and Stank, 1999; Earl 1989; Narasimhan and Kim, 2001; Zhao, Dröge, and Stank, 2001). A company's ability to gain competitive advantage in the marketplace is linked to information exchange (Daugherty, Myers, and Richey, 2002; Deeter-Schmelz, 1997; Glazer, 1991; Parsons, 1983; Porter, 1980; Porter and Millar, 1985; Rayport and Sviokla, 1995; Whipple, Frankel, and Daugherty, 2002).

Hence, a company that can collect and disseminate competitive and market related data in a timely manner will improve functional integration, coordination, and decision making (Sanders and Premus, 2002). This capability can be significantly enhanced with the exchange of information with external partners, which is the topic of Chapter 3.

The last key logistics capability required for a supply chain orientation is evaluation. Evaluation involves the monitoring of internal and external operations of the firm. Logistics evaluation capability gives feedback on the fit and suitability of other logistics capabilities (Fawcett, Smith, and Cooper, 1997). Evaluation is important as “if you cannot measure it, you cannot control it” and therefore can not improve it (Harrington, 1991: 164). Assessment includes targets for customer and supplier outcomes to promote performance. It is important to design evaluation criteria that are continually updated to focus on changing customer and supplier needs. Ultimately, firms can refer to measures such as activity based costing and economic value added to measure the level of value created. Performance measures such as profitability tend to focus on a single company instead on the extended supply chain. Hence, Bechtel and Jayaram (1997) advocate the use of integrated measures together with more traditional non-integrated measures. An example for an integrated performance measure is cash to cash cycle, that spans at least two neighboring organizations in a supply chain. Measuring performance, both at company and supply chain level remains to be a popular topic.

2.3 The impact of uncertainty on firms

The strategic planning process must be carried out in the light of uncertainty. Uncertainty is a key factor that affects profits and costs and hence the success or failure of the strategic plan. To understand the impact of uncertainty on firms the following discussion explores the concept of uncertainty.

Uncertainty according to Knight (1921) is defined as outcomes that occur with a probability that cannot even be estimated. Thus, Knight makes an important distinction between the term risk, which has a probability distribution and uncertainty, which does

not. Galbraith (1973) defines uncertainty as “the difference between the amount of information required to perform a task and the amount of information already possessed”. Risk according to Mitchell (1999) is defined as a subjectively-determined expectation of loss; the greater the probability of this loss, the greater the risk thought to exist for an individual. Thus the concept of risk has two elements: the probability or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence (Royal Society, 1992).

Uncertainty in the context of supply chains and more specifically in manufacturing is caused by supply uncertainty, demand uncertainty, new product development uncertainty, and technology uncertainty (Koh and Tan, 2006). Supply uncertainty relates to unpredictable events that occur in the upstream part of the supply chain. Among the causes to supply uncertainty are shortages of materials and late deliveries. Clearly, supply uncertainty can disrupt manufacturing and have an adverse affect on sales, where distributors and retailers down the chain are also affected. Demand uncertainty can be defined as unpredictable events that occur in the downstream part of the supply chain (Koh and Tan, 2006). Demand uncertainty (or demand risk) can result from seasonality, volatility of fads, new product adoptions or short product life cycles (Juttner, 2005). Furthermore, Chung, Anthony, and Michael (2004) identify three sources for the uncertainty of demand arising (i) from the final consumer, (ii) the behavior of the economic system at the current time, and (iii) the immediate downstream customers. Another uncertainty related to manufacturing concerns new product development. New product development uncertainty can stem from unpredictable events during the process of market research, product design, and product prototyping. Finally, technology uncertainty refers to the fuzziness in the selection of a suitable technology platform (Koh and Tan, 2006). An example is the trade-off between a fool-proof manufacturing technology (perhaps dated), compared to a prospective technology offering better price to performance but whose viability is not certain (Krishnan and Bhattacharya, 2002). Furthermore, uncertainty can also arise from political (e.g. fuel crisis), natural (e.g. fire, earthquake), and social uncertainties (e.g. strikes) (Juttner, 2005).

Approaching the concept of uncertainty from the transaction cost economics (TCE) point of view will significantly contribute to the understanding of the value of information sharing between organizations. The concept of uncertainty is central to TCE, which assumes that individuals have bounded rationality and act opportunistically. The early transaction cost literature did not make a distinction between different forms of uncertainty. More recent literature has disaggregated the construct of uncertainty (Meuleman et al., 2006). For example, Williamson (1985), who built on Koopmans (1957), distinguished between primary and behavioral (or secondary) uncertainty. Primary uncertainty refers to the underlying transaction and arises from mainly exogenous sources such as uncertainty relating to natural events, consumer preferences, regulations, and technology (Sutcliffe and Zaheer, 1998). Primary uncertainty may lead to problems of communication, technological difficulties, and coordination problems that can as a consequence adversely impact the execution of transactions (Meuleman et al., 2006). Behavioral uncertainty refers to the risk of opportunism on transactions that are executed through incomplete contracts.

Similarly, Sutcliffe and Zaheer (1998), classified uncertainty as primary, competitive, and supplier uncertainty. Primary uncertainty is consistent with Koopmans' (1957) and Williamson's (1985) and refers to the "lack of knowledge of states of nature" (Sutcliffe and Zaheer 1998:6). Competitive uncertainty arises from the innocent or strategic actions of potential or actual competitors (Sutcliffe and Zaheer 1998). Supplier uncertainty is essentially behavioral uncertainty and refers to possible opportunism by upstream or downstream partners. On the other hand, in organizational theory uncertainty is often referred to as environmental uncertainty (Thompson, 1967) and includes a number of factors such as uncertainty regarding suppliers and competitors actions, as well as uncertainty in regulations and technology, which captures both primary and behavioral uncertainty.

Based on the reviewed literature, the definitions of the various types of uncertainty are not consistent. Some definitions overlap, whereas others ignore certain factors. For the remainder of the thesis, external uncertainty will include supplier, demand, and environmental uncertainty. Supplier, demand, and environmental uncertainties are

primarily caused by external factors to the company. However, uncertainty could also arise from company specific factors such as long product to market cycle times as well as long lead times. Nevertheless, the focus of this thesis is on factors external to the focal company. Having discussed uncertainty and sources for uncertainty, the next section explains how uncertainty affects decisions and costs.

2.3.1 Decision-making under uncertainty

At the microeconomic level, the assumptions of mainstream economics originate from neoclassical economics (Campus, 1987). The neoclassical economic framework includes a number of different assumptions. For example, it is assumed that the decision maker has available, at no cost and with no uncertainty, all the information required to work out any decision problem and to arrive at a profit-maximizing solution using the principles of marginal analysis (Scapens and Arnold, 1986). However, the assumptions of the conditional truth (under conditions of certainty) are naive. Hence, different fields such as management accounting have included statistical decision theory and information economics into their frameworks (Ryan, Scapens, Theobald, 2002) to deal with uncertainty and the cost of acquiring information. In statistical decision theory, outcomes are associated with a probability. Hence, decision makers select the decision that yields the highest utility, given that they are fully rational and utility maximizers. Furthermore, “the provision of information can reduce uncertainty, but as information is a costly good, its production should be evaluated in terms of its costs and benefits” (Ryan et al. 2002:73). Thus, this approach replaced the conditional truth by a costly truth, where information production costs are considered in decision models although the provision of information is itself problematic.

One of the main contributions of information economics to management accounting was that it caused researchers to distinguish between information system choice and information system design (Demski, 1972). This is important because previously researchers had mainly focused on design issues that had resulted in increasingly complex techniques (Ryan et al., 2002). Thus, this provided a rational for selecting

simple methods compared to complex alternatives, which cannot be justified on a cost-benefit basis.

2.3.2 Uncertainty, risk and firm costs

Risk was previously defined as uncertainty that is measurable (Knight, 1921). Thus, both the literature on supply chain risk and uncertainty will provide valuable insights into the adverse effects of uncertainty on costs. Cucchiella and Gastaldi (2006) identified various types of risks derived from a number of internal and external uncertainty sources. These are presented in Table 1 below. Uncertainty regarding capacity refers to the shortage or limitation of resources to carry out a project (i.e. the production of existing products or the development of a new product). Lack of information can, among other things, result in wrong decisions regarding product innovation and launch.

Another source for internal uncertainty can relate to an organization's ability (or inability) to work together or to adopt new technologies. Risks resulting from external uncertainties are related to competitor action, demand, political environment, price fluctuations, technology, suppliers, nature, and, security. Competitor actions can in the worst case eliminate the achieved competitive advantage if, for example, the competitor enters a market, which previously had one seller: the focal company. Manufacturing yield refers to the uncertainty about demand, where the actual demand might turn out to be lower, leading to reduced yield. The opposite can be certainly true too. The uncertainty in the political environment of a country or certain region can also pose a risk as forced restrictions on, for example, imports and exports might cause shocks to production and sales. Uncertainty regarding prices of direct materials as well as end products can lead to profit variation, which affects business risk. Technology uncertainty can make products obsolete (e.g. floppy disks versus compact discs), hence posing a risk on future profits. Supplier risk refers to the risk that suppliers cannot deliver the desired products on time. The acts of nature such as floods and fires can also

pose a risk. Finally, there is the risk of security, which can arise from theft, sabotage, and terror.

Table 1: Risks arising from uncertainty

Uncertainty	Risk due to uncertainty item
Internal sources	
Capacity	Financial Capacity: not having the necessary assets to realize a project Production Capacity: the project is too large or complex Structural Capacity: the network does not have the required infrastructure
Information	Lack of information necessary for the right definition of product characteristics Lack of information for the right moment of product launch
Internal organization	No cooperation among actors Low ability to adopt new technologies
External sources	
Competitor action	Competitor action can eliminate the achieved (competitive) advantage
Manufacturing yield	Low demand for products Demand higher than estimated
Political environment	Not being able to forecast the actions of authority
Price fluctuations	Not being able to cover the costs due to price fluctuations
Technology	A new technology on the market could make the product obsolete
Supplier	Delivery: not being able to deliver right products and quantity on time Quality: not being able to deliver products with desired specifications
Nature*	Natural disasters such as floods and fires can disrupt the supply chain (traffic being a subset)
Security*	Theft, sabotage, and terror can also disrupt the supply chain

Source: Cucchiella and Gastaldi (2006:706)
* added

Uncertainty regarding demand is very problematic. As companies usually cannot estimate demand for their products accurately, they hold excess inventories of finished goods. This is to mitigate the risk in case demand is greater than forecasted and to prevent stockouts and order delays, which results in customers switching to

competitors' products. Furthermore, when demand is higher than expected, additional direct materials for production are required if demand is to be met, which puts pressure on capacity. Availability of direct materials, if not buffered for, is subject to supplier uncertainty. Hence, an imbalance in supply and demand can therefore lead to costly rescheduling of production, backlog orders, buffer inventories, obsolescence, loss of sales, and eventually to over- or under-investment in fixed and non-fixed assets.

To illustrate the impact of uncertainty, it might be interesting to look at the production planning process. A firm must plan production well ahead (e.g. 6 months in advance) of sales so as to make all the required purchases for raw and direct materials and for budgeting purposes. Particularly, the existence of uncertainty poses a great challenge for the production planning process of a firm. The goal of the production unit is often to find the optimum quantity to produce that minimizes total costs given a number of constraints. This can be expressed as following (Voss and Woodruff, 2002):

minimize: $\sum_{i=1}^{N} C(i)\, X_i$

subject to: $X_i \geq D(i)$

where:
i = products 1 to N
C(i) = cost of product i
x_i = quantity of product i to be determined by the model
D(i) = demand for product i

Here, there is only one constraint $\chi_i \geq D(i)$, which requires production to be equal or greater than the demand for the product. Without this constraint, the model would be optimized at 0 or negative production, which is not realistic. This is a very simple optimization model but it captures the essence of production planning. Even this simple model requires demand to be known. In reality, the optimization function and the constraints are much more complex. More realistic models can include a large set of

variables. Table 2 presents some of the common variables used in production planning systems such as in Manufacturing Resource Planning (MRPII) (Voss and Woodruff, 2002). The column in the middle explains each variable and the column on the right shows the origin (e.g. supplier or customers) and the impact of external uncertainty on the estimation of the corresponding variables when planning production.

Table 2: **Impact of uncertainty on variables used in production planning**

Variable	**Explanation**	**Origin: Impact of external uncertainty**
Resources	The different raw materials or components used to produce the products, which is derived from the Bill of Materials.	supplier: strong
Beginning inventory	The number of finished products already available in the warehouse(s).	demand: strong
Lead time for SKU	The time required between the issuing of an order for production/shipment and receiving it by the customer.	supplier: strong
Capacity, overtime and extra capacity cost	The resources (machines, labor) of the firm. This also refers to the possibility of increasing capacity (e.g. additional labor hours) but at a given expense.	demand: moderate
Inventory holding cost	The cost of capital tied up in inventory stored.	environment: moderate
Tardiness	SKU's can be produced with some delay but this is typically penalized.	demand: low
Penalty for changes to the plan	A stable production plan is almost as important as a good production plan. If changes to the production plans are frequent, production workers will learn to ignore the plan, which is undesired. This idea is captured by introducing a cost object.	demand: low
Multiple routings, substitutes, and subcontractors	Sometimes choices can be made regarding suppliers, factories, or production lines (multiple routings). The same suppliers can also offer alternate products required to make the same SKU (substitute). Production can also be assigned to subcontractors if inhouse production is not feasible.	demand: strong

Variable	Explanation	Origin: Impact of external uncertainty
Transportation and expedited shipping	When an SKU can be made in an alternate location, the marginal cost of transportation must be included in the model. Furthermore, to avoid late delivery, expedited shipments must be incorporated as an additional cost to the system.	demand: low
Waste (due to changeover)	Waste can arise from changeovers of SKU's as the first runs are usually needed to adjust the machines for new production.	demand: low

(table continued from previous page)

The type of resources used in production are not very likely to change in the short run but their availability in the future will depend on the suppliers. Hence external uncertainty, specifically supplier uncertainty has a strong impact on estimation. Regarding beginning inventory, it is a direct function of past period production and demand. Consequently, the effect of uncertainty on this variable is large and it might be hard to estimate beginning inventory for future periods when demand is uncertain. Similarly, lead times of finished products are highly dependent on the availability of raw and direct materials, especially when the firm uses lean production methods such as Just-in-Time: materials are only purchased when they are needed. Machine capacity in the short run is highly inflexible but labor capacity can be increased immediately through extra shifts. In the long run, both types of capacities can be fully adjusted. Assuming that a company adjusts capacity according to production requirements, the estimation of capacity levels in the future will be somewhat difficult when adjustments occur frequently. Hence, it can be claimed that uncertainty overall has a moderate affect on the estimation of this variable. The inventory holding costs per unit is based on the cost of capital and is relatively easy to estimate. However, uncertainty regarding interest rates might lead to estimation problems. Values for tardiness can be estimated with no great difficulty, thus the impact of external uncertainty is low. The remaining variables can be estimated with relative accuracy except for substitutes and subcontractors. These variables will be subject to their availability. One must note here that the longer the planning horizon, the larger will be the estimation error and uncertainty.

In production planning, planners deal with uncertainty in two main ways: 1) to base estimations on optimal target values or 2) through scenario planning (Voss and Woodruff, 2002). In the first method, variables such as demand are decomposed into two parts: deterministic and stochastic demand. The deterministic part can be estimated using methods such as multiple regression but the stochastic part is treated as random. For planning purposes, demand is then set according to the deterministic value and for the stochastic part, certain policies such as buffers can be used. In the second method, the planner creates different scenarios by changing the parameters and then attempts to hedge against uncertainty.

To further understand the impact of uncertainty on costs, one should also refer to transaction costs. Transaction costs are the costs incurred when purchasing a product or service, i.e. the cost of searching, bargaining, and contracting. Transaction costs have had a large impact on economic theory and facilitated a theory of the firm, as follows:

> *"Within a firm, … market transactions are eliminated and in place of the complicated market structure with exchange transactions is substituted the entrepreneur-co-ordinator, who directs production."* (Coase, 1937:388)

Transaction cost economics (TCE) emphasizes the cost of transactions in explaining the size of a firm. According to TCE, it is the magnitude of transaction costs, which determine whether market or hierarchical types of transactions are economically more efficient (Coase, 1937). According to Coase (1937), when transaction costs are too high, firms prefer to vertically integrate.

Transaction costs can be divided into coordination costs and transaction risk (Clemons and Row, 1992). According to Clemons and Row (1992:3), "coordination costs are the direct costs of integrating decisions between economic activities. Transaction risk is associated with the exposure to being exploited in the relationship".

Uncertainty can impact transaction costs as higher levels of primary uncertainty can increase coordination costs. Coordination costs increase as a result of primary uncertainty because when uncertainty increases, different expectations and goals about

future supply requirements develop (Artz and Brush, 2000). This can be explained with an example from Artz and Brush (2000): If a supplier is unable to accurately predict the price of its product inputs, it will be reluctant to enter into a contract, which locks it into a fixed price for an extended period of time. Uncertainty can also impact transaction costs as higher levels of behavioral uncertainty can increase transaction risk, i.e. the risk of opportunism.

Figure 2 summarizes the main costs arising from external uncertainty. The figure depicts a company faced with the three types of uncertainties resulting from the supply side (upstream), demand side (downstream) and the environment. The uncertainties are overlapping for two reasons. First, because environmental uncertainty can cause demand or supply risk for the supply chain (Juttner, 2005). For example, a fire (environmental uncertainty) that damages the warehouse of a supplier can cause supplier uncertainty for downstream firms. Second, some definitions of environmental uncertainty can include elements from supply and/or demand uncertainties (see, for example, Hoque and James, 2000; Chang et al., 2002).

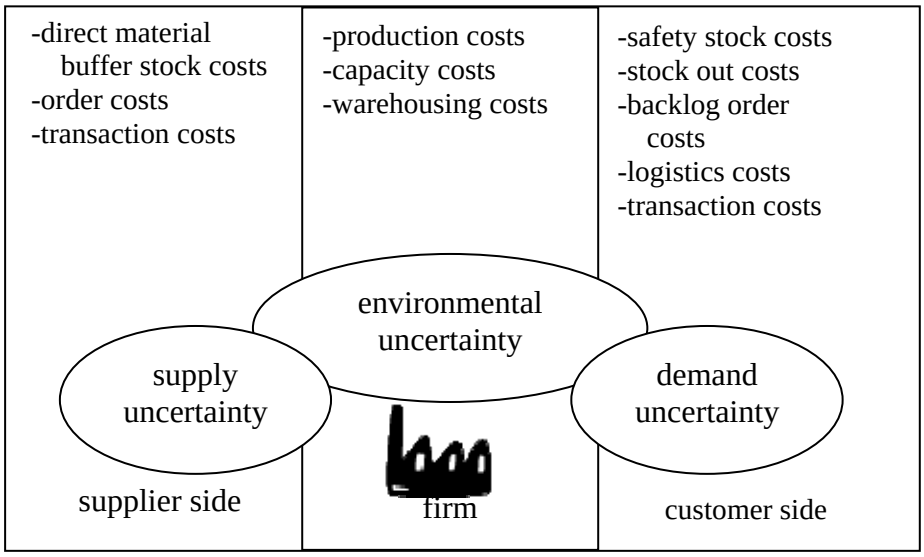

Figure 1: Impact of uncertainty on firm costs

In Figure 1, costs related to the supply of materials (supplier side) are shown on the left and costs associated with the sales of products are given on the right (customer side). As the figure illustrates, companies faced with demand uncertainty keep buffer inventories

for direct materials and finished products, especially when stockout costs and backlog order costs are high. Furthermore, the determination of the optimum reorder point (e.g. by using the economic order quantity) for materials is hard when product demand cannot be estimated accurately (leading to higher order costs). This, coupled with problems in deliveries such as backlog orders, translates into higher logistics costs. As the figure illustrates, uncertainty also impacts production, leading to suboptimum production and capacity decisions. Decisions regarding capacity planning are strategic level decisions in the manufacturing industry. When demand and availability of capacity is uncertain, the timing and sizes of capacity decisions are complicated. Firms often must make these decisions under substantial risk because of the capital intensiveness and the irreversible nature of capacity adjustments (Cheng, Subrahmanian, Westerberg, 2004). Uncertainty also increases transaction costs, especially coordination costs (e.g. cost of contracting). Hence, uncertainty regarding demand and supply leads to suboptimum production, capacity, and warehousing, which translates into higher costs.

The advantage of reducing uncertainty is very clear; companies can improve the cost structure, asset utilization, and increase the quality of earnings as a result of lower business risk. So, how can companies deal with uncertainty? Information processing theory offers some explanation.

There are three important concepts identified in information processing theory: information processing needs, information processing capability, and the fit between the two to obtain optimal performance. Timely and accurate information is vital for organizations to cope with environmental uncertainty and improve their decision-making. There are three strategies organizations can adopt to cope with uncertainty and increased information needs: (1) develop buffers to reduce the effect of uncertainty, (2) align environmental uncertainties (i.e. demand, supplier, competition, technology) with manufacturing flexibility (Chang et al., 2002), and (3) implement structural mechanisms and information processing capability to enhance the information flow and thereby reduce uncertainty.

A classic example of the first strategy is to build buffer inventory to reduce the effect of uncertainty regarding demand or supply. Another example is to add extra safety buffers in product design due to uncertainty in product working conditions. This has been the most common strategy but opportunity costs, obsolescence, and storage costs have continuously put pressure on companies to reduce them.

The second strategy involves the adding of flexibility and agility to the production and logistics to absorb demand shocks and produce in just in time (JIT) fashion. Added capacity replaces the need for inventories as extra capacity (together with low set-up-times) allows swift production to meet demand. Such production also requires small batch sizes, which can create waste if not controlled for. In this type of production system, one talks about the switch from a push to pull system where production occurs when demand arises, i.e. when an order is made. The Toyota manufacturing system popularized this concept in the 80's. However, the switch to such a system is not easy and certainly costly as processes must be reengineered and extra capacity made available.

The third strategy involves the improvement of information flows between organizational units as well as organizations. Although additional buffers and agility can be built into the supply chain, the third approach to managing uncertainty is more direct at addressing the problem and possibly more cost efficient. This is the main subject of this dissertation, which is elaborated in the next chapter.

2.4 Conclusion

This chapter focused on the sources of competitive advantage for firms and the role of environment in strategy formulation. Different theories, such as SSP, RBV and transaction cost theory have made similar claims: Firms must take into account the environment (market, customers, suppliers, etc.) when making strategic choices. With a given strategy, the right resources must then be identified and the structure of the company aligned with its strategy, which will lead to competitive advantage.

The intense competition and increased environmental complexity of the recent years have fostered collaboration between companies. The recognition of the importance of the supply chain versus the self-centered view of the organization has led to a concept referred to as SCO. A successful SCO requires logistics capabilities. This requires investing resources in key capabilities that facilitate functional competence at the SBU.

A discussion on uncertainty and how it affects decision-making, risk, and costs of a company has emphasized the need to deal with uncertainty at all organizational levels. Better information in terms of quality and timeliness that is available for decision-making can optimize processes and plans (at all levels). Three ways to cope with the problem of uncertainty have been identified: to increase buffers, to increase flexibility/capacity, and to share more information. The last alternative warrants more investigation as this seems to be the most cost-efficient way to deal with the problem of uncertainty.

3 Information Sharing

3.1 Introduction

This chapter focuses on information sharing between firms and begins with a discussion of its advantages (3.2). Section 3.3 presents various methods discussed in literature on collaboration between buyers and suppliers, which require a high level of information sharing between companies. Section 3.4 deals with the means of communication between collaborating companies and the increasing role of IT as a facilitator. In both sections (3.3 and 3.4), evidence from prior studies provides the level of adoption of the presented practices and means. Factors known from previous literature that affect the intensity of information shared between companies are presented in Section 3.5. Section 3.6 concludes the chapter.

3.2 Information Sharing: Why?

The last chapter discussed the role of uncertainty in strategy and how it affects the functioning of the firm as a whole. The conclusion is that decisions made in relatively stable environments with minimum level of uncertainty produce optimum economic outcomes. Thus, information sharing between companies can help companies make better decisions and minimize costs.

In a supply chain, it is unlikely that all companies are equally informed about the environment, e.g. product demand, trends, and emerging technologies. Thus one can talk about information asymmetry among companies, i.e. between competitors and within (upstream – downstream) supply chains. A company that has better information about, for example, customer expectations compared to its competitors can take advantage of the situation: it can, for example, enter a new market as the first company leading to the first-mover advantage. Thus, information asymmetry between competitors is desirable from the perspective of a company with information advantage. Such companies will prefer to maintain the information asymmetry with its competitors

as long as possible because when information diffusion is asymmetric in the market, those companies first receiving/creating necessary information will have an opportunity to capture value from the market before the increased competition through information spreading will remove all possibilities to earn economic profits (Ekholm and Wallin, 2006).

Regarding information asymmetry within the supply chain, downstream companies might have, for example, more information about product demand than upstream companies, as they are closer to end consumers. A good example of this is the use of customer loyalty cards by retailers, which keep track of consumer purchases. This data can provide valuable information about consumer trends to which suppliers don't have access. Furthermore, demand is also a function of downstream customers. Thus uncertainty regarding downstream demand adds to the uncertainty (regarding the actual consumer demand) of the focal firm. On the other hand the buyer is also faced with uncertainty resulting from the supplies. This uncertainty relates to the ability of the supplier to supply direct materials when required. (Ho et al., 2005).

Information asymmetry and the lack of transparency in the supply chain can lead to a phenomenon referred to as the bullwhip effect: the amplification of demand variability as orders move up the supply chain (Forrester, 1958; Lee et al., 1997). Jones and Simmons (2000) provide evidence for this finding from the food industry, whereas Naim, Disney, and Evans (2002) report on the bullwhip effect in the automotive sector. There are three sources of the bullwhip effect: (i) demand signal processing, (ii) rationing game, (iii) order batching, and (iv) price fluctuations (Lee et al., 1997). The first source refers to the process of forecasting sales. For example, when a retailer records a larger than average sale for a certain period, this could lead the retailer to adjust its forecasts upwards, so that an even larger order is placed upstream. When this process is repeated using the distorted demand information upstream, the initial demand is largely amplified. Order gaming refers to orders made due to speculation of, for example, shortages of direct materials (Lee et al., 1997) or in anticipation of their price increases. This creates an artificial demand, which is exacerbated by the demand signal processing phenomenon. Order batching is a third factor for the bullwhip effect resulting from ordering in large batches due to, for example, large ordering costs versus

inventory holding costs. Large batches ordered relatively infrequently do not give timely information about the trends of the market, leaving upstream firms little time to adjust to fluctuations. Finally, promotions by suppliers can result in large variances in sales, creating an artificial and temporary demand for materials and products.

To reduce uncertainty and the bullwhip effect, companies in the supply chain can share demand forecast information to reduce the costly bullwhip effect, as well as information on inventory levels, sales data, order status, and production schedules (Lee et al., 1997). Companies can also share information about other variables relating to, for example, economic developments, new regulations, and upcoming technological developments, referred to as environmental uncertainty (e.g. Hoque and James, 2000).

Information sharing between firms refers to information shared between a buyer and key suppliers that is detailed enough, frequent enough (Carr and Smeltzer, 2002; Humphreys et al., 2004; Krause and Ellram, 1997), and timely enough (Dyer, 1997; Krause and Ellram 1997; Leek et al., 2003) to meet a firm's requirements. Here, the scope of information is much broader than the information exchanged between buyers and sellers for transaction processing purposes. Hence, for the reminder of the thesis, information sharing will refer to the sharing of private and discretionary information, what is beyond the information required to carry out the transactions. Through information sharing, for example, changes in consumer preferences can be distinguished from artificial demand fluctuations caused by promotions or order batching. Furthermore, the exchange of R&D information can help companies cut down on development and production costs.

3.3 A social perspective on information sharing

One can also analyze supply chain relationships from an organizational socialization theory point of view. Various articles in executive management journals have emphasized the critical impact of learning and social networks in driving improved supply chain performance. To give an example, the social interactions between buyers

and sellers in supplier associations were found to play an important role in driving problem solving and cost reductions (Stuart et al., 1998). Furthermore, Bessant et al. (2003) also showed that supply chain learning created through the sharing of common experiences is an important means of transferring appropriate practice.

There are two complementary approaches that explain buyer supplier relationships. These are the theories of relational social network governance (Granovetter, 1985; Jones et al., 1997; March and Olsen, 1976 and March, 1991) and relational governance (Dyer and Singh, 1998; Nishiguchi, 1994). The main idea of these theories is that when organizations invest in relation-specific assets, engage in knowledge exchange, and combine resources through governance mechanisms, a supernormal profit can be derived on the part of both exchange parties. Dyer and Singh (1998) refer to this benefit as “relational rent”. The relational view of the firm suggests that buying and supplying firms systematically share valuable know-how with each other and make relationship-specific investments in return for access to profit from rents that can only be generated by working jointly. However, is it argued that knowledge exchange and investment in relationship-specific assets will take place under conditions where the expected value of the combined inflows of knowledge and investment exceeds the expected loss/erosion of advantages due to knowledge spill-overs to competitors (Dyer and Singh, 1998; Osborn and Hagedorn, 1997). This issue is further discussed in Chapter 4 Section 4.4 on information sharing between firms and the risk of opportunism.

The concept of socialization is a key element in organizational behavior research. Socialization can be defined as the intensity of interaction between, and communication of, various actors within and between the firms, which leads to the building of personal familiarity, improved communication, and problem solving (Gupta and Govindarajan, 2000).

In the context of supply chains, socialization involves the process by which individuals in a buyer–supplier engagement acquire knowledge of the other enterprise's social values and norms (Van Maanen and Schein, 1979). This might, for example, include learning about rules of thumb, special language, prejudices, and models for social etiquette (Cousins et al., 2006). The process of socialization leads to buyers and sellers

identifying the gaps that may exist in the way they conduct their work practices. Once any gaps are identified, there are two options: (1) the parties elect to discontinue working together if the gaps are too large or (2) the parties work to narrow the gaps between their respective organizational social values and in so doing jointly promote the success of the relationship. It requires time and effort to effectively go through the socialization process and to minimize any gaps - but otherwise the success of the relationship is unlikely. However, if the parties successfully close the gaps, they can then begin to reap the rewards of the socialization process, which takes the form of relational capital.

Regarding buyer–supplier relationships, supply chain relational capital can be defined as the configuration and social structure of the group through which resources are accessed (Cousins et al., 2006). The level of relational capital can be assessed by the degree of mutual respect, trust, and close interaction that exists between the partner firms. This conceptualization of relational capital suggests that investments in socialization processes produce various benefits and goodwill that have the potential to generate real benefits to the buyer such as reduced supply chain costs, greater flexibility, and reduced new product development time. In such situations, suppliers are willing to work more efficiently due to more concise and accurate information sharing, responsive technical assistance, joint improvements in training, process control, and direct investment in supplier operations, in return for the benefits of improved performance and joint value creation (Zajac and Olsen, 1993). Both parties are also more willing to share information, dedicate human resources to the improvement effort, and invest in specific machines, apparatus, or instruments to satisfy the buyer for the same reason (Cousins et al., 2006).

3.4 Information sharing and collaboration practices between firms

The supply chain literature provides an extensive list of collaboration possibilities between firms. These practices require a lot of communication and information sharing between buyers and suppliers compared to the traditional transactional buyer-seller

relationships. The list below will provide an idea about such practices and the kinds of information flows they require.

- **Demand Collaboration (Joint Forecasting):** Companies can optimize production, capacity, inventory, and logistics much better if customer demand is more certain. Thus, better demand forecasts, through joint forecasting efforts with other firms in the supply chain can provide better estimates about upcoming demand. Information on planned campaigns and promotions, which can cause sudden demand shocks to the supply chain, are also reported to other members. Kahn, Maltz, and Mentzer (2006) distinguish between four types of demand collaboration based on the intensity of information technology employed and the intensity of interorganizational relationships.

- **Joint Inventory Planning:** Joint inventory planning involves collective target setting for supply chain members' inventory levels. Thus, once targets are set, supply chain members are committed to these inventory levels and are penalized if they, for example, build up inventories. A popular practice that relates to joint inventory planning is Vendor Managed Inventory (VMI) (e.g. Haavik, 2000). In VMI, the supplier takes control of replenishment. Thus, suppliers have full visibility into buyers' inventory levels so that orders are made on behalf of the buyer when a critical level is reached. Benefits of VMI include lower inventories, reduced stock-outs, and stabilization of orders on an agreed basis.

- **Logistics Coordination:** The function of logistics is to ensure that the right goods are in the right place at the right time (La Londe, 1983). Research has indicated that collaboration and logistics integration need to be achieved across enterprise boundaries, linking external suppliers, carrier partners, and customers (Chen and Paulraj, 2004). Coordination or integration of logistics activities can generate savings to the company if deliveries and warehousing are better coordinated so that fleet and space utilization is at a maximum. This is typically achieved by information sharing in (or close to) real time.

- **Collaborative Planning Forecasting and Replenishment (CPFR):** This is a comprehensive scheme whereby supply chain members create a joint business plan on agreed issues such as demand forecasts, minimum ordering quantities, lead-times, and ordering intervals. CPFR (Aviv, 2001; Bradley, 2001; Sherman, 1998) includes the already discussed concepts like joint production planning, joint logistics coordination, demand forecast collaboration, and joint inventory planning. The ultimate goal is again to reduce supply chain costs and improve supply chain performance.

- **Joint Capacity Planning:** Suppliers and buyers share information on capacity and future capacity requirements. This is to ensure that suppliers have adequate capacity to produce or make available the required items and services in the required time. The major benefit of joint capacity planning is to avoid supply chain disruptions due to shortages of materials and services (Petersen et al., 2005).

- **Joint Production Planning:** Supply chain partners share production plans in order to inform members about future material and services requirements. Joint production planning leads to better resource allocation as supply chain uncertainty is reduced.

- **Joint Goal/Target Setting:** Companies have various performance measurement systems such as the Balanced Scorecard and Six Sigma quality assessments for monitoring performance (including supplier performance). Joint goals and targets attempt to ensure that there are mutually acceptable performance targets that are rooted in common/aligned goals (Petersen et al., 2005). Hence, giving regular feedback on the agreed performance goals through common metrics can trigger better corrective actions.

- **Collaborative Research and Design:** A scheme whereby supply chain partners have access to product conceptualization, design and manufacturing information. Hence, with the product data being readily available to external parties during its

development and production, their feedback can be utilized for better decision-making. Demand for new products and changes to existing products occur at a rapid pace. Thus transparency in the supply chain can trigger rapid adjustments/corrections (e.g. production and capacity adjustments) when, for example, a change to the bill of materials occurs. Collaboration in new product development can lead to increased innovation, reduced product to market times, reduced costs of projects and, improved quality of projects (Perona and Saccani, 2004).

- **Customer information sharing:** As more customer information (including satisfaction) is reported to upstream members, customer requirements are better understood at an earlier stage of the supply chain, which can then affect customer satisfaction positively. Improved customer information can lead to better quality and price decisions as well as better customer segmentation.

- **Open book accounting**: Supply chains can be better optimized when there is full supply chain transparency on the factors that govern it. Thus, open-book accounting (Carr and Ng, 1995, Seal et al., 1999, Mouritsen et al., 2001) has emerged as a technique that, for example, allows interorganizational cost management (IOCM). IOCM involves a set of activities, processes, or techniques that managers can use to manage costs that span organizational boundaries (Cooper and Slagmulder, 2004). Some of these activities might include traditional cost management practices (e.g. budgeting, target costing), while other techniques might not be related to conventional management accounting (Fayard et al., 2006). Open book accounting has long been practiced in Japanese keiretsus – a set of companies with close business relationships and shareholdings.

- **Supply Chain Management (SCM):** SCM as defined by the Global Supply Chain Forum is "..the integration of key business processes from end user through original suppliers that provide products, services, and information that add value to customers and other stakeholders" (Lambert et al., 1998:1). SCM

goes beyond the dyadic framework and views the supply chain as one entity, where all companies in the supply chain (2-tier, 3-tier, …) collaborate. Although SCM strives at seamless integrated information and physical distribution along the supply chain, in reality, SCM is often only partially, and at the dyadic level implemented (Fawcett and Magnan, 2001). SCM in essence involves many of the above concepts such as CPFR and joint logistics coordination with the aim of optimizing the entire supply chain rather than the operations of one firm, although this goal is somewhat naive. Supply chain planning and advanced planning and scheduling (APS) fall under SCM. Based on the Global Supply Chain Forum, eight key processes make up the core of SCM (Cooper et al., 1997). The key processes refer to managing customers, demand, orders, production, suppliers, product development and, reverse logistics. The key business processes span the entire length of the supply chain and cut across firms and functional silos (e.g. marketing and production) within each firm (Croxton et al., 2001). The supply chain practices enumerated above tackle these processes so as to enable a smooth but cost efficient flow of materials and services to end customers.

Regarding the actual extent of information shared between companies in the supply chain, the literature provides some evidence. A Finnish survey conducted by Kemppainen and Vepsäläinen, (2003) with a sample of 25 companies in electronics, mechanics, and paper industries reported that order-specific information such as lead times and order status was shared more than planning information (e.g. sales forecasts, production capacity). Some differences were found between companies that mainly small firms shared less information than larger firms. The analysis showed that information sharing was limited and companies to a large extent hesitated to collaborate beyond order processing and operational scheduling within the dyadic supplier-buyer relationships.

Olhager and Selldin (2004) studied SCM practices in a sample of 128 Swedish manufacturing firms. Results indicated that the most important area for collaboration (within the entire supply chain, upstream and downstream) was forecasting. They also

reported that collaborative planning of capacity, inventory and production was used to some extent but considerably less than collaborative forecasting. Furthermore, the use of supply chain planning and control tools such as VMI, SCP, APS, and CPFR were found to be under 15%. A comprehensive Nordic survey by Bagchi et al. (2007) reported that the highest degree of collaboration with key suppliers was in R&D (37%), procurement (33%), and distribution (29%). The lowest percentage of high collaboration was found in supply chain design (13%), manufacturing (15%) and supply chain software (16%). The low percentage of collaboration in manufacturing surprised the authors given the recent focus on concepts such as JIT, lean production, agility and clock-speed competition.

Studies from outside the Nordic region (e.g. Fawcett and Magnan, 2002; McAdam and McCormanck, 2001; Fröhlich and Westbrook, 2001) found similar results. Perona and Saccani (2004) reported from an Italian study that integration techniques belonging to the domain of operations (e.g. JIT, VMI, CPFR) had the highest diffusion: 84% of companies at least had adopted one technique. Regarding the domains of technology (e.g. new product development, joint re-design, joint technological innovation) and strategic planning (e.g. coordinated business focalization, coordinated market expansion plans), results showed 58% and 21% adoption rates respectively. Thus Perona and Saccani (2004:197) indicated that “value creation is sought by firms in the domain of day-by-day operational processes, more than through agreements in long term strategic planning”, which was consistent with other studies. Based on a study by Patterson, Grimm, and Corsi (2004), only 15% of U.S. firms adopted supply chain planning systems, although this finding does not provide any insight into less formalized ways of sharing information. Overall, it is possible to conclude from the above studies that information integration between companies was found to be strong at the operational level rather than at the strategic level.

3.5 Information sharing and the role of IT

The means of communication with suppliers (and customers) is an important factor for effective supplier development (Carr and Kaynak, 2007). Previous studies have recognized the influence of the means of communication on the extent of information sharing and supplier development in the fields of information technology, marketing, and SCM (Argyres, 1999; Dewett and Jones, 2001; Leek et al., 2003). Carr and Kaynak (2007) categorize communication methods into two broad groups: traditional communication methods and advanced communication methods. Literature reports that both methods are used in combination (e.g. Leek et al., 2003).

Traditional communication methods include the use of telephone, fax, e-mail, and face-to-face contact (Dewett and Jones, 2001; Leek et al., 2003). Advanced communication methods refer to computer-to-computer links. Examples of modern communication methods are Electronic Data Interchange (EDI) and interconnected information systems (e.g. ERP) using private or public networks (Ellram and Hendrick, 1995; Sahin and Robinson, 2005; Shore and Venkatachalam, 2003; Sririam and Stump, 2004). EDI facilitates electronic communication with trading partners across a company's borders and permits organizations to generate electronic purchase orders, invoices, bills of lading, and various other documents and sends them instantly to trading partners anywhere in the world (Soliman and Janz, 2004).

Companies have been investing in IT for decades but the Information and Communication Technology (ICT) revolution of the 1990's significantly accelerated this trend. Many companies today have advanced IT capabilities and Electronic Commerce (EC) has become a major way to do business. E-commerce "is the use of electronic means to exchange information and conduct business transactions within and across organizational boundaries" (Soliman and Janz 2004:697). E-commerce can be divided into three groups depending on who is the target of the seller market: business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C). B2B e-commerce involves the online transactions between business, institution, or government agency and another (Chiu, 2002). Hence, from the perspective of EC, the

focus of this study is B2B. Technologies associated with e-commerce include EDI, direct link-ups with suppliers, Internet, Intranet, Extranet, and electronic catalogues (Gunesekaran and Ngai, 2004).

Initially e-commerce referred to the sales and marketing of products and services over the Internet but today it can involve, among other things, into interorganizational business applications that allow collaboration, for example, SCM. These business applications have been developed by companies such as SAP, Manugistics, and i2, which in effect facilitate the implementation of the previously discussed information sharing/collaboration practices (refer to Section 3.4) through software applications. For example, SAP's SCM solution, which consists of supply chain planning and collaboration, supply chain execution, and supply chain visibility design and analytics (SAP, 2007) attempts to optimize supply chain related processes at the operational, tactical, and strategic level. A great enabler in this process is the sharing of information between supply chain partners.

E-commerce systems are evolving and IT adoptions have been in the past and still at present hindered by a number of factors including financial (Min and Galle, 1999), technical, and organizational factors. IT investments generally require large resources both in labor and capital. Although the e-commerce bubble burst and ERP implementation failures have to some extent slowed down the electronization of businesses, it remains to be an ongoing trend. The rationale for computerization is explained and supported by a large body of literature, which investigates the positive link between IT and performance. Although the initial results were somewhat contradictory, which became known as the productivity paradox (Brynjolfsson, 1993), more recent evidence supports this relationship. Companies that have invested in IT have been able to maintain (Hunton et al., 2003) or to improve their performance (e.g. Hitt and Brynjolfsson, 1996; Hitt et al., 2002). Thus, with IT becoming ubiquitous, investments in IT today help companies to maintain their competitive advantage rather than being a source for it.

The integration of interorganizational information systems continues to pose a challenge to companies. Most companies have only recently been able to integrate their in-house systems through an ERP system. However, the development of the Extensible Markup Language (XML) standard and XML-based standards such as the Extensible Business Reporting Language (XBRL), as well as the emergence of open source softwares and development frameworks are making this task much easier. These initiatives have a major impact on interorganizational systems as they can be run on any computer platform.

Another barrier to the adoption of IT solutions for interorganizational information systems are data security concerns (Soliman and Janz, 2004). Security has been a problem to computing ever since computers came into existence. However, the problem has been exacerbated by the establishment of networks. Networks pose a big threat to enterprise systems as they allow access from other computers within the network, opening up the possibility for fraud committed by unauthorized transactions. Furthermore, computers can intentionally or unintentionally harm each other by sending malicious code such as viruses, Trojans, and worms over the networks. The effects can be very costly leading to, for example, business interruptions, data loss/spoilage and litigation. Whereas dedicated networks are relatively secure, more and more businesses today use the more cost efficient public networks such as the Internet. In recent years, software vendors have developed a variety of softwares to protect networks. One of them is the Virtual Private Network, which uses encryption technology to secure communication on public networks. Virus Scanners are also widely used, which scan incoming/outgoing traffic to prevent malicious code. Although security in information systems is improving, new threats and vulnerabilities are emerging rapidly.

Organizational factors that affect IT usage includes culture, resistance to change and attitudes and perceptions (e.g. perceived usefulness, ease of use) towards systems (Lucas, 1981) and technology (Davis, 1989). Overcoming these barriers are much harder than technical issues. A field referred to as organizational development, which has evolved into change management, tackles this issue. Change management includes a wide range of intervention strategies that may enhance human performance directly or

indirectly. This includes process consultation, work restructuring, strategic HRM planning, the design or development of IT solutions (e.g., user interface design) (Worren, Ruddle, Moore, 1999), as well as training. A striking feature of change management is that it is viewed as only one component of a larger organizational change effort; the other components being strategy, business processes and technology (Worren et al., 1999).

Regarding the actual diffusion of technologies used to exchange information between companies, Olhager and Selldin (2004) provide some evidence. They reported that phone, fax, and e-mail were the most prevalent ways to communicate in the studied supply chains, whereas e-market places and EDI were relatively underutilized. However, they also found that in the near future, electronic communication such as e-mail, EDI, and Internet-based extranets were expected to increase. Although Kemppainen and Vepsäläinen (2003) did not differentiate between the use of information systems based on intra or interorganizational use, their results could shed some light. Most common information systems used within a company included order-handling, inventory management and ERP systems. Particularly, the use of ERP systems can be regarded as enablers of information sharing as they are relatively scalable, thus allowing for the bridging of ERP systems between organizations. In this respect, Patterson, Grimm, and Corsi (2004) found one third of manufacturing companies having adopted ERP systems. To conclude this section, it seems that even though advanced communication methods are becoming more common, it is unlikely that they will replace the more traditional means of communication completely.

3.6 Previously known factors affecting information sharing

Based on the evidence from previous studies, information sharing in the supply chain is still a limited phenomenon. Lack of trust between companies is probably the mostly cited cause. Trust can be an enabler as well as a consequence of information sharing. For example, Hart and Saunders (1997) suggest that greater levels of trust increase the probability of a firm’s willingness to expand the amount of information shared through

EDI. Similarly, Petersen et al. (2005) reports that antecedents to effective collaborative planning include trust. According to Inkpen (2001), partners are more willing to exchange accurate and timely knowledge when engaged in a trust-based relationship. Thus, if a partner expects opportunistic behavior, it can withhold or exchange inaccurate information so that information is no longer valuable (Inkpen, 2001). Trust has always been a central point in research relating to inter-organizational cooperation. Trust can be defined as:

> *"…the reliance by one person, group, or firm upon a voluntarily accepted duty on the part of another person, group or, firm to recognize and protect the rights of all others engaged in a joint endeavor or economic exchange."* (Hosmer 1995:393)

Trust is also the decision to rely on a partner with the expectation that the partner will act according to a common agreement (Curall and Inkpen, 2002) and not opportunistically. For any level of trust, there is a certain amount of relational risk as a partner may not act according to the agreement (Ireland and Webb, 2007) or expectations. Nevertheless, partners accept the elevated risk to benefit from the social and economic benefits associated with trust-based relationships. According to Hart and Saunders (1997), trust between organizations in EDI implementations consists of competence (how efficiently information is processed), openness (the ability to listen and share new ideas), caring (joint goal setting and refraining from opportunism), and reliability (consistent behavior). More generally, antecedents to trust include the satisfaction with a supplier's performance and the strength of the relational norms (Ryu, Park, Min, 2007), which was also discussed in section 3.3 on socialization. TCE does not address trust in terms of how it forms between organizations and how it should be managed to sustain organizational effectiveness and efficiency (Ireland and Webb, 2006). It is actually the lack of trust, which is the foundation of TCE (the idea that individuals and organizations will act opportunistically if not controlled).

Another important factor in interorganizational relationships is firm power. Power is commonly categorized as coercive or non-coercive and involves an influence that can be used to evoke desired actions from partners (Ireland and Webb, 2007). Through coercive power, actors can control negative outcomes with the intention of gaining

rewards from a partner either through punishment or threatened sanctions (Molm, 1997). On the other hand, non-coercive power is executed by providing or withholding rewards in promoting desired behaviors. According to Cox (2001), non-coercive power provides numerous relational advantages, such as the ability to overcome lack of consensus and reach fast decisions and promote innovation and change to address environmental opportunities and threats. The role of power has also been recognized regarding the subject of information sharing between companies. For example, Hart and Saunders (1997) and Webster (1995) found that power can be used to force partners to adopt EDI. Power in supply chains can originate from several sources, including the number of major customers of a supplier's component, a supplier's market share of a given component, the number of suppliers from which a buyer purchases a particular component, the number of potential suppliers for a given component, and the amount of revenue a supplier generates from a single buyer (Krajewski et al., 2005).

Resource dependency theory provides insight into power's formation and management in interorganizational relations. Firms are viewed as interdependent and seek to manage uncertainty that is affecting them (Pfeffer, 1988). Different patterns of interdependency exist depending on which part has control over a valuable and scarce resource. Firms lacking the control of scarce resources manage the resulting uncertainty through means such as mergers & acquisitions, board or director interlocks, and various forms of interorganizational relationships (Pfeffer and Salancik, 1978). TCE provides a view regarding power with respect to how firms gain power with transactions. The assumption is that almost every firm participating in interorganizational relationships wields a certain amount of power (Ireland and Webb, 2007). In every interorganizational relationship, there is also a firm which has relatively more power than the other. This however does not mean that the weaker cannot influence the more powerful. The weaker firm can create conditions in which the powerful firm would incur significant costs if it were to act opportunistically.

Information quality was reported to be an antecedent to information sharing (Petersen et al., 2005; Moberg et al., 2002). This is logical since information that is unreliable can negatively affect decisions. Thus partners will avoid information sharing when the

information exchanged is of low quality. Moberg et al. (2002) also found that relationship commitment was an antecedent to strategic information exchange (information exchange was divided as operational or strategic). Relationship commitment refers to the current state and the future expectations of the partners regarding the relationship: i.e. whether the relationship is expected to continue/strengthen and if considerable effort and investment is put into building the business with the supplier. Carr and Kaynak (2007) found that the level of internal information sharing was positively related to information sharing between companies. Other papers argue for the link between the level of uncertainty and information sharing. This topic is discussed in the next chapter.

3.7 Conclusion

This chapter has focused on information sharing between companies. Information is shared as better access to information can improve decision making and lower costs, which was the topic of the previous chapter, and because information asymmetries exist between firms. A review of the socialization theory in the context of supply chains suggested that when organizations engage in knowledge exchange, a supernormal profit can be derived on the part of both exchange partners.

There are various ways companies can collaborate, but the underlying premise is that information is shared freely without many restrictions. VMI and CPFR, which fall under a more general concept known as SCM seem to have achieved some foothold among companies. However, based on the evidence provided by the literature, information sharing in general is still limited and mostly exercised at the day-to-day operational level.

IT has been increasingly used as a facilitator for information sharing but the use of traditional communication methods (e.g. face-to-face contact, phones, etc.) remains strong. The software industry jointly with consultants has been developing and offering an increasing number of applications and solutions that link companies together.

Finally, evidence from prior studies suggests that trust and power are significant factors that explain the level of information shared between companies. This is not surprising as information sharing opens up the possibility of opportunism. Since trust can be considered as the opposite of opportunism (Barney and Hansen, 1994), an increase in trust is likely to increase the willingness to share information. Power on the other hand can be used to force the weaker firm to provide information.

A review of the literature on information sharing indicates that the topic is relatively unexplored, which is not consistent with the amount of attention it has received from academia recently. Many concepts that fall under SCM revolves around the idea that companies would freely share information. However, this is in most cases not true. Regarding the limited knowledge on the topic coupled with scarce empirical evidence, a further investigation into the topic is well justified.

4 Hypotheses Development

4.1 Introduction

Given the lack of adequate explanation and empirical evidence on the subject, this chapter identifies a number of factors that might explain the intensity of information shared between companies. The underlying theory for this chapter is TCE, which was extensively referred to in the previous chapters. In sections 4.2 to 4.5, several hypotheses are developed. Section 4.6 concludes the chapter with a model for information sharing between a focal company and its key suppliers.

4.2 Uncertainty and information sharing

In Chapter 2, the link between uncertainty and costs was established. It was concluded that the greater the level of uncertainty a firm faces, the larger its costs will be due to suboptimum decisions regarding strategy and operations (e.g. production) and because of higher transaction costs as propounded by TCE. Chapter 3 discussed the existence of information asymmetries between firms that arise due to firms' unique positions in the supply chain and their relative capabilities in acquiring information. Since information asymmetries exist, and more so when uncertainty is high, companies are likely to share information. Thus, it is evident that uncertainty might play a role in determining the intensity of information shared between companies in a supply chain. Furthermore, the relationship between uncertainty and information sharing is to some extent posited by contingency theory, which states that the amount of uncertainty and rate of change in an environment affects the development of internal features in organizations (Lawrence and Lorsch, 1967).

With respect to the sign of the relationship between uncertainty and information sharing, the literature is ambiguous. Kaufman and Mohtadi (2003) claim, "information sharing and information withholding might take place depending on the degree of initial uncertainty". This also agrees with Fisher (1997), where different supply chain

strategies depending on the product characteristics (functional versus innovative) apply. Furthermore, Moshowitz (1997) argues that in stable conditions, as characterized by standardized products, companies are more likely to reap the benefits of cooperation. However, when companies operate in temporary supply chains for the lifespan of the market opportunity (Kumar 2001), closely coupled processes may not be appropriate (Moshowitz, 1997). On the other hand, Xu (1996) claims that manufacturers will find it more difficult to plan when demand is more variable, encouraging them to share more information. Similarly, according to Lee et al. (2000) the value of shared information will be higher when the underlying demand is highly correlated over time, highly variable, or when the lead time is long. Also, the analytical models of Bourland et al. (1996) and Gavirneni (2001) predict the value of information to increase with variance in demand. In contrast, the models by Schouten et al. (1994), Chen (1998) and Gavirneni et al. (1999) predict the opposite. Therefore the literature on the relationship between information sharing and demand uncertainty in the supply chain is not very consistent.

The relationship between uncertainty and information sharing was tested in previous research (Kulp, 2002; Li and Lin, 2006, Zhou and Benton, 2007). The following table summarizes the empirical results.

Table 3: Hypotheses between uncertainty and information sharing

Reference	**Hypothesis (Predicted Sign)**	**Significance (Actual Sign)**
Kulp (2002)	demand variability → use of VMI (+ or -)	insignificant
Li and Lin (2006)	customer uncertainty → information sharing (+)	insignificant
	supplier uncertainty → information sharing (+)	significant (-)
	technology uncertainty → information sharing (+)	insignificant
Zhou and Benton (2007)	supply chain dynamism → information sharing (+)	significant (+)

Information sharing in Kulp (2002) was operationalized as the extent of use of Vendor Managed Inventory, where the supplier has full visibility into the customer's (e.g. retailer) inventory. However, results did not support the hypothesis. A similar

hypothesis was proposed by Li and Lin (2006), where environmental uncertainty consisted of three dimensions relating to the uncertainty of customers, suppliers, and technology. Again, no support was found except for the relationship between supplier uncertainty and information sharing, which was surprisingly negative. Recently Zhou and Benton (2007) found support for a positive link between supply chain dynamism and information sharing. Supply chain dynamism in Zhou and Benton (2007) referred to the pace of changes in both products and processes.

Based on theory and the reviewed literature, there is a strong argument for a relationship between uncertainty and information sharing. However, as mentioned above, there is no consensus over the sign of this relationship. Furthermore, two overlapping but distinct characteristics of uncertainty seem to dominate the literature: uncertainty regarding the environment and uncertainty about consumer demand. At the operational level, reducing demand uncertainty as well as environmental uncertainty is paramount so that production schedules can be followed as planned. For the purpose of strategy, minimizing uncertainty is equally important so that the right capabilities that allow for competitive differentiation are developed. The relationship between uncertainty and information sharing is expected to be positive thus agreeing with Xu (1996). Moreover, assuming that information asymmetries are likely to be higher when the level of external uncertainty is high, higher uncertainty will motivate companies more to share information. Hence the following two hypotheses are proposed.

Hypothesis 1: Environmental uncertainty is positively related to the intensity of information shared with key suppliers.
Hypothesis 2: Demand uncertainty is positively related to the intensity of information shared with key suppliers.

4.3 Asset specificity and information sharing

In Section 2.3.2, transaction costs were discussed, which consist of coordination costs and transaction risk. It was established that uncertainty affects both coordination costs

and transaction risk adversely. However, transaction risk can also arise from asset specificity. Asset specificity can increase transaction risk (Coase, 1937) because asset specific investments can encourage behavioral uncertainty (the risk of opportunism). To better illustrate this, the next section focuses on asset specificity in more detail.

Asset specificity refers to the degree of investment made by the supplier of goods and/or services for a specific buyer (Williamson, 1985). Asset specific investments include site specificity, physical asset specificity, human asset specificity and dedicated assets (Williamson, 1993). Investments in assets are specific, as they cannot be put to work without a significant loss for other purposes. An example for site specificity would involve a supplier locating near a buyer so as to reduce transportation costs. Once in place (the plant), assets become highly immobile. Physical asset specificity refers to investments made for machinery and equipment that are specific to a particular transaction. It might be, for example, the case that a buyer requires highly customized components for which special machinery is needed. The machinery is an asset specific investment if there is no market for the components produced by this type of machinery outside the exchange in question. Physical asset specialization enables product differentiation and may improve quality by increasing product integrity (fit) (Dyer, 1996). Human asset specificity arises as a result of learning by doing and the time and effort invested in the procedures due to underlying transactions. The fourth type of asset specific investments refers to dedicated assets: e.g. investments by suppliers that require the sales of a significant amount and where losses would be incurred if contracts were terminated prematurely. Malone et al. (1987) added time specificity as the fifth type: an asset is time specific when its value is highly dependent on its reaching the customer within a specified period. This is the case in many transactions nowadays as competition is fierce and buyers have many alternatives compared to the past pre-globalized era.

Asset specific investments enhance trade (Perry, 1989) and can act as an important resource in creating and maintaining competitive advantage. However, transaction-specific investments are more likely to lead to competitive advantage when safeguards against opportunism can be put into place with relatively low costs and when task

interdependence is high (Dyer, 1997). The risk of opportunism due to asset specific investments is addressed in the next paragraph. Task interdependence refers to “the extent to which the items or elements upon which work is performed or the work processes themselves are interrelated, so that changes in the state of one element affect the state of the other” (Scott, 1981:211).

Asset specificity can be regarded as a lock-in or as some degree of dependency on the other firm. A company that relies on one or few companies for its purchases or sales can be said to be dependent on the other. Before discussing the risks of asset specific investments, it is necessary to introduce the concept of dependency in an exchange relationship, as asset specific investments can be regarded as a form of dependency. In the literature, dependency between companies is a function of the criticality of the resource (Thompson, 1967; Pfeffer and Salancik, 1978; Bourantas, 1989, Sririam, Krapfel and Spekman, 1992; DeJong and Noteboom, 2000) and availability of alternative suppliers and/or buyers (Thompson, 1967; Pfeffer and Salancik; Sririam, Krapfel and Spekman, 1992; Geykens et al. 1996; Kim, 2001; Buvik and Halskau, 2001). Also switching costs have been found to play a role in determining the level of dependency (Bourantas, 1989; Sririam, Krapfel and Spekman, 1992; Johnson, 1999; Buvik and Halskau, 2001). Switching costs are those costs incurred when having to switch from one supplier to another when purchasing the same goods. The costs might be both monetary (labor time spent) and non-monetary (including routines and procedures for dealing with a particular supplier) (Dick and Basu, 1994, Heide and Weiss, 1995).

When a company is dependent on another, the concept of “power” might arise. In fact, power has been a popular concept in explaining certain buyer supplier relationships. However, the term power itself is not very informative, as the source for power requires some explanation. Furthermore, the basis for power is dependency (Emerson, 1962). Hence, dependency is found to be a better term and power will therefore not be used as a term in the remainder of the study.

Asset specific investments produce resources that are likely to be critical to a company, e.g. those that allow a company to differentiate from its competitors. This means that a company with asset specific investments will have few if any and at high cost, alternative exchanges for the transactions in question. In other words asset specific investments will produce very high switching costs for the investor. Since criticality of resources, availability of alternatives, and switching costs are characteristics of dependency and asset specific investments are related to them, one can claim with caution that asset specificity causes “asset specific dependency”.

Asset specific investments can lead to the risk of opportunism. A buyer that observes its supplier having no alternative buyers due to asset specific investments can use its monopoly power to ask for price reduction. There is a well-known case study of Fisher Body (FB) and General Motors (GM) (Klein et al., 1978) which is somewhat an extension of this idea. FB, a U.S. company, supplied specific automobile bodies for GM, which required an initial investment by FB (asset specific investment). This had put FB in a vulnerable position as it became dependent on GM to buy its customized parts. GM could have exploited its power and demanded smaller prices or threatened to buy less. To avoid the hold-up potential, FB made a 10-year contract with GM, requiring GM to buy all its parts from FB. The contract also protected GM by preventing FB from charging higher prices to GM through the provision of most favored nation so that the price could not be greater than charged to other customers for similar products. However, due to uncertainty and the difficulty of specifying all elements of performance, their contract was imperfect, as all contracts are. The price was set at a margin above labor and transportation costs. Thus FB took advantage of this arrangement by adopting a relatively inefficient, highly labor-intensive technology and by refusing to locate the body-producing plants adjacent to GM’s assembly plants. GM, unsatisfied with the prices, eventually acquired the company (vertical integration). Although the exact account of events is a controversy (see Coase, 2006), nevertheless it demonstrates the workings of the transaction cost theory. Moreover, additional cases with similar events support the idea that the risk of opportunism due to asset specific investment may lead to vertical integration (Klein, 2005).

Because transaction specific investments open up the possibility of opportunism, TCE proposes safeguards against the hazards. According to TCE, dispute resolution requires the involvement of a third party such as the state, which can enforce legally binding contracts (Williamson, 1991). Contracts are viewed as the primary means of safeguarding transactions although they are seldom perfect, not to mention highly costly, when having to specify many contingencies. However, less formal alternatives to contracts have also been suggested in the literature: relational or goodwill trust (Dore, 1983, Sako, 1991) and reputation (Weigelt and Camarer, 1988). Some scholars claimed that self-enforcing safeguards such as relational trust are more efficient and effective means of safeguarding transactions (Sako, 1991; Smitka 1991; Hill, 1995). It is therefore believed that Japanese transactors have lower transaction costs than U.S. transactors because they have developed an institutional climate that nourishes relational trust (Sako, 1991; Hill, 1995).

To alleviate the risk of opportunism, companies might choose to share more information with key suppliers in an attempt to increase relational trust. Information sharing can also be considered as an investment into the relational capital, so as to generate goodwill. The next hypotheses are formulated based on the logic that greater dependency between companies might encourage them to share more information to reduce the risk of opportunism and increase trust. However, information sharing might also lead to more risk – the risk of opportunism. Thus, companies that have already made asset specific investments might be reluctant to share information as this might put them even into a more vulnerable position. Nevertheless, the first claim seems to be more persuasive and the following hypotheses are proposed:

Hypothesis 3: A key supplier's dependence on the buyer is positively related to the intensity of information shared with the key supplier.
Hypothesis 4: A buyer's dependence on key suppliers is positively related to the intensity of information shared with the key supplier.

4.4 Risk of opportunism and information sharing

Information can be viewed as an asset (King, 1984). The provision of private information can then be regarded as an asset invested into the exchange relationship. This is comparable to an asset specific investment. However, this “investment” as opposed to the classical view of asset specificity does not necessarily make the invested asset (information) less useful when employed elsewhere. Furthermore, the provision of private information is not mandatory; it is likely to be voluntary to enhance transactions. However, similar to an asset specific investment, it might lead to a power shift in the bargaining position of the involved parties due to opening the possibility for opportunism. The investment (or risk of opportunism) can be regarded as a negative investment being equal to the net present value (NPV) of the future losses of financial benefits in case of opportunism. Hence, companies will share information only up to the point where the benefits of sharing information will be equal to or greater than the NPV of future losses due to opportunism. This type of reasoning is also captured in real options theory. In reality, companies will find it hard to quantify the benefits and the risks of information sharing and decisions might have to be made based on rules of thumb rather than marginal analysis.

Information in the wrong hands or when abused can expose a company to risk. For example, a supplier that knows its buyer’s upcoming production might increase the price of direct materials as the buyer is now in a weaker position. On the other hand, a buyer might demand a lower price from a key supplier if the excess supplier inventory is known, leading to risk of obsolescence if not purchased and utilized soon. Also unintentional harm can arise from information sharing in the form of spillovers. To give an example, a firm might predict the actions of its competitors if they share a common supplier – hence a competitor could make the launching of a new product line less effective if a counter action is taken (e.g. simultaneous launch by the competitor). Similarly, a competitor that obtains the date for a certain promotion could jeopardize it by engaging itself in a promotion just some days before.

Given the risk of information sharing, it should therefore not be surprising that companies might hesitate to share private information with their trading partners. Evidence from the literature supports this assertion. For example, Bagchi and Skjoett-Larsen (2005) reported from a European survey (n=149) that companies were cautious when sharing information. This finding was consistent with Kemppainen and Vepsäläinen (2003), Akintoye et al. (2000), Eng (2003), Dekker (2003), and Bagchi and Skjoett-Larsen (2002), where resistance to sharing proprietary data was found or argued.

The risk of opportunism becomes relatively more important when there is more at stake: when the NPV of a company's future income is relatively large. This is the case when a company offers a unique product that faces low competition and can therefore generate high economic rents. To do so, companies must foresee future opportunities in advance so as to invest in the right products and capabilities on time. A company can do this successfully if it possesses unique knowledge about market conditions and future customer requirements, due to perhaps advanced business intelligence, capabilities and/or relational capital. Once companies start developing capabilities and products, it then becomes a matter of protecting this information so as to be able to reap the benefits of their future monopoly power as long as possible. Hence companies might be reluctant to share information at an early stage of the Product Life Cycle (development or growth stage), as this could lead to a relatively larger risk of opportunism. Wagner (2003) provides some evidence about this phenomenon. Wagner (2003) reported that there are patterns relating to the phase of integration efforts (e.g. product development stage) and the intensity of integration with suppliers. For example, the optics and precision industry (e.g. cameras, medical and surgical devices) tends to integrate only at a latter stage (industrial stage), as they often need to protect their know-how by avoiding integration at the R&D stage. Bagchi and Skjoett-Larsen (2002) claim that companies in rapidly evolving industries prefer not to integrate but as the opportunistic behavior threat recedes with industry maturity, firms open up gradually. Thus, the fifth hypothesis is proposed based on the product life cycle stage of the focal company.

Hypothesis 5: The intensity of information shared with key suppliers is positively related to the product life cycle stage of the buyer.

Having put forward the above positive hypothesis, it is acknowledged that there might be a negative relationship between information sharing and the product life cycle stage. This might be true due to a smaller level of uncertainty faced by the focal company when at the mature or declining stage, which warrants the opposite based on hypothesis one and two.

4.5 Information sharing and performance

There is a large body of literature that focuses on interorganizational collaboration and how this affects productivity and performance. The implicit assumption in such studies is that shared information is of value. The value of information is largely based on its ability to affect decisions (Choudhury and Sampler, 1997). Hence, time specificity is an important element that affects the value of shared information, where information about current events is considered to be more valuable then information about past events.

Douglas and Pohlen (2001) provide a framework of how collaboration with suppliers and customers can affect economic value added (EVA). Figure 2 illustrates how EVA is affected by Supplier Relationship Management (SRM) - a comprehensive approach to managing supplier relations for the purpose of improving purchasing. SRM in its core, as with other SCM initiatives has information sharing.

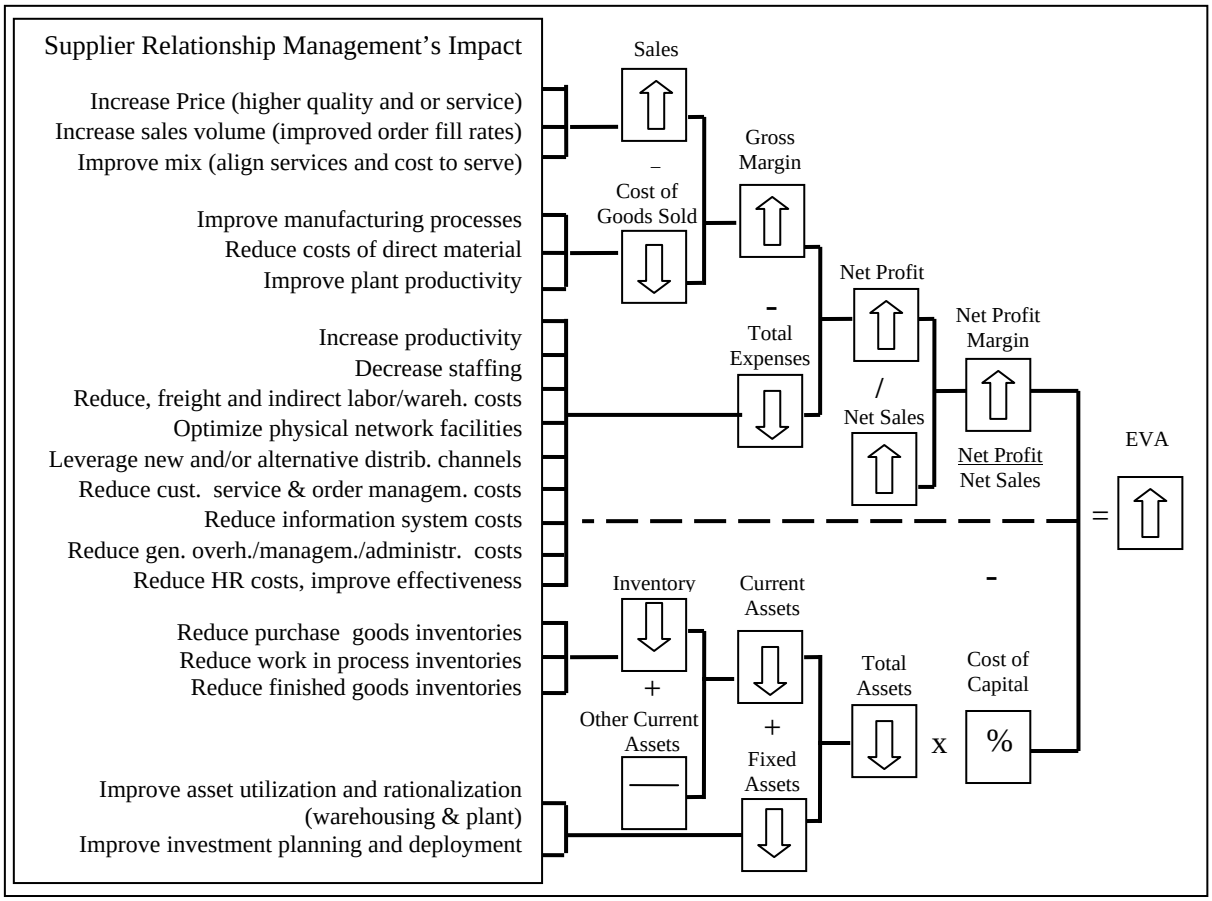

Figure 2: How SRM Affects Economic Value Added
Source: Douglas and Pohlen (2001:11)

As Figure 2 illustrates, EVA is a function of net profit margin and the product of cost of capital and total assets. The constituents of net profit and total assets are further shown to the left and also how they affect EVA (an arrow pointing up for positive effect or down for a negative effect). Thus sales, for example, has a positive effect on EVA as opposed to the cost of goods sold. The effects of SRM are presented on the right, which in turn affect the constituents of EVA. Thus looking at the first item on the left, revenue from sales can be increased as a result of an increase in price, sales volume or a better product mix. To give a concrete example, SRM, which involves information sharing with suppliers, can increase the quality of goods with a timely notice to the supplier about an upcoming surge in demand and can eliminate rush orders and tight production schedules, resulting in better operations.

The early stream of research in the area of SCM dealt with the use and benefits of interorganizational information systems such as the EDI. EDI, which was also presented earlier, is essentially a network (private or public) that links two or more companies to facilitate structured data interchange. The use of such technology and its impact on costs has been extensively documented (e.g. Bakos, 1991, Cash and Konsynski, 1985, Johnston and Vitale, 1988). However, this research focused explicitly on the exchange of operational data, e.g., prices, purchase orders, and invoices. For example, electronic market places, facilitated through IT, reduce the cost of searching for obtaining information about product offerings and prices (Bakos, 1991). In the recent years these marketplaces have become more functional and much of the purchasing and selling related work can be automated using XML based technologies (e.g. Rosetta Net).

More recent research focused on the impact of sharing information of a more proprietary nature such as demand forecasts and inventory levels. This research, for example, found that collaborative planning with suppliers has a positive effect on supplier quality, responsiveness, and delivery performance (Larson and Kulchitsky, 2000; Petersen et al., 2005). Furthermore, according to Saeed et al. (2005), supplier integration, enabled through interorganizational systems, reduced transaction costs and lead time uncertainty.

Information sharing with suppliers can improve more than supplier delivery performance. For example, results of Petersen et al. (2005) showed that structured collaborative planning, which included supplier scheduling, forecasting and inventory positioning, and inventory visibility and capacity planning, was positively associated with inventory turns. Similarly, results obtained from a survey of manufacturing companies in Europe indicated a positive impact of integration with suppliers on operational performance (e.g. order fulfillment lead time, order fill rate, production flexibility, logistics costs, inventory turnover) (Bagchi and Skjoett-Larsen, 2005). Surprisingly, a negative correlation between the length of relationship with suppliers and performance measures was also found. A study by Saeed et al. (2005) reported that "…higher levels of integration and interorganizational systems initiation significantly contributed toward enhancing process efficiencies…", which included among others,

inventory turnover. Li, Nathan, Nathan, and Rao (2006) reported that effective SCM is positively associated with among others, a better ROI, market share, sales growth and overall competitive advantage. Cassivi et al. (2004) showed that effective SCM, through efficient e-collaboration tools, led to significant improvements in three performance measures - output, resources, and flexibility. It is interesting in their findings that the strength of the efficiency of supply chain planning and execution systems was more significant upstream than downstream. This is "partly explained by the fact that the information coming from suppliers through the collaboration tools is usually configured to the manufacturer's desired format as opposed to retailer, thus facilitating the integration with the manufacturer's internal systems (e.g. ERP system)" (Cassivi et al., 2004). The authors also noted that the link between the efficiency of e-collaboration tools and the three performance measures (resource – output - flexibility) were not influenced by firm size and position in the supply chain. Furthermore, companies valued flexibility measures most highly, followed by output measures and resource measures. The study used the three performance dimensions developed by Beamon (1999), which were also used in this study. Furthermore, Perona and Saccani (2002) found that supplier-buyer integration led to numerous benefits in new product development, operations management, and strategic planning. They noted that especially overperforming companies adopted tools for product development whereas growth companies integrated more in strategic planning. A study by Straub and Klein (2004) found evidence that information sharing and dependence positively affected networked organizational performance. Not surprisingly, there was also evidence that interorganizational IT, aligned with the primary buyer or network leader, had a positive effect on strategic and operational performance (Sanders, 2005).

There are also counter-arguments about the benefits of information sharing. For example, Disney, Naim and Potter (2004) claim that information sharing will not lead to improvements but that coordination of activities is crucial. The need for coordination of activities is certainly a valid point but whether information sharing as such will have no value remains to be seen. Furthermore, Graves (1999) argued that there is no value of information as companies can, for example, use their own business intelligence (competencies) to reduce uncertainty. Although it might be possible to, for example,

estimate demand from past figures, it does not invalidate the usefulness of information sharing because there are other methods. Finally, Bask and Juga (2001) warn about integration rather than information sharing and advocate a more selective approach toward integration.

Based on the literature review, evidence for the positive relationship between the intensity of information shared with key suppliers and performance appears to be strong. In this study, three distinct performance measures are of interest regarding supply chain output, resource and flexibility (Beamon, 1999). This leads to the following three hypotheses.

Hypothesis 6a: The intensity of information shared with key suppliers is positively related to resource performance.
Hypothesis 6b: The intensity of information shared with key suppliers is positively related to output performance.
Hypothesis 6c: The intensity of information shared with key suppliers is positively related to flexibility performance.

4.6 Conclusion

This chapter reviewed the literature on information sharing and identified a number of factors that might affect its intensity. Demand uncertainty and uncertainty regarding the environment have been identified as determinants of information shared between a buyer and its key supplier. Furthermore, drawing from TCE, asset specific investments, both as physical and social capital have also been proposed to explain information sharing. These costs represent the dependence (hence the label) of a company on another. The hypotheses are proposed to have a positive relationship with the intensity of information shared although the counter- arguments have also been presented.

The literature review also provided evidence that collaboration in one form or the other (e.g. SCM, process integration) has a positive impact on firm performance in terms of

productivity and profitability measures. However, very few studies have measured performance comprehensively, and little is known about the relative impact of information sharing on the different aspects of performance.

The reviewed studies in this chapter have limitations. The most important limitations relate to sample size, number of industries, as well as the instruments used. Hence, knowledge on information sharing is found to be rather limited. Several links between known concepts remain unexplored. The literature calls for further empirical research (e.g. Bask and Juga, 2001; Li et al., 2006) on the dynamics of information sharing. To address this need, the below model (in Figure 3) is proposed, which attempts to explain the intensity of information shared between a focal company and its key suppliers.

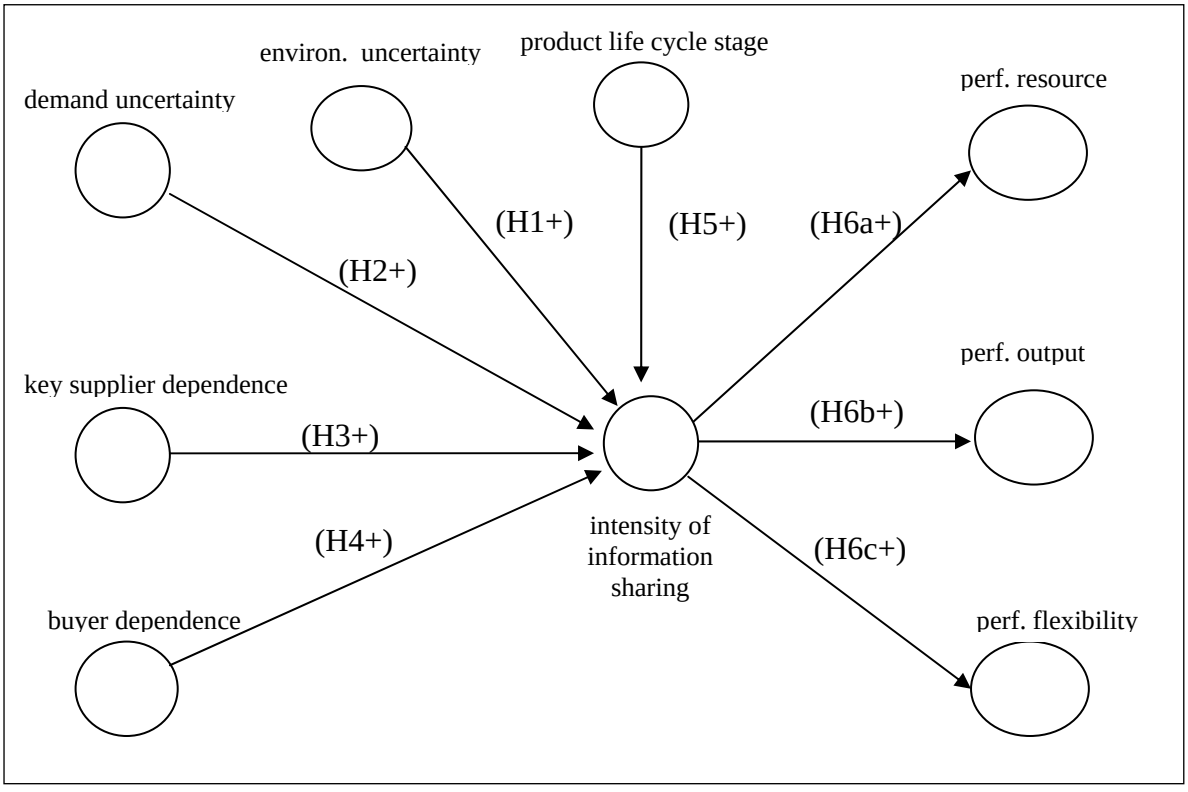

Figure 3: Research Model and Hypotheses

5 Research Method

5.1 Introduction

This chapter provides information about sample selection, survey design, measurement of variables, and the method for hypothesis testing. The chapter is summarized in Section 5.6.

5.2 Sample

The sample of Finnish companies was obtained from the Voitto database. The sample of Swedish companies was acquired from the largest companies in the Nordic countries database. The two databases were accessible from HANKEN's network. The selection criteria for the Finnish and Swedish companies were the following:

- a turnover of 15 million EUR minimum (140.000 mskr for Sweden; 1 EUR = 9.27 – May 2006)
- manufacturing, assembly companies and companies which distribute or sell those products (distributors and retailers)
- excluded raw material extractors as the key-supplier concept is less relevant to them

The first criterion was chosen in order to limit the sample size. This was done in favor of large companies. Larger companies have more resources and the scale of operations justifies the use of more advanced information systems for collaboration, where cost saving incentives are more significant.

Service companies (other than distributors and suppliers) were excluded from both Finnish and Swedish samples, as many of the issues related to manufacturing companies such as inventory optimization, obsolescence, and stockouts do not necessarily apply to service companies.

The query returned 1170 companies from Finland, which were fully retained in the sample. For Sweden, the database returned 2581 companies with the selected criteria. The sample was substantially larger than the desired size for Sweden, which was about the size of the Finnish sample. Hence, half of the Swedish companies were eliminated. The procedure for random sampling was made in the following way. First, companies were ordered according to turnover. Then, every second company on the list was discarded, resulting in 1290 companies. Hence, the final sample for Finland and Sweden (Finland: 1170, Sweden 1290) totaled 2460.

The respondent in the target companies was the purchasing manager. Purchasing managers were considered to have the most knowledge about suppliers and performance. Managers were appropriate as high-ranking respondents are more likely to provide reliable information than their subordinate ranks (Philips 1981).

The 1170 Finnish questionnaires were sent by post on the last week of February 2006 to the Finnish companies. A total of 134 responses were received within a period of 6 weeks. More than half of the responses were received within the first 2 weeks. Three questionnaires were returned as undelivered. Fifteen responses were unusable as either data was missing or because the company was a subsidiary of a foreign company and as it mainly purchased from key suppliers within the group. The total response rate (134/1167) was 11.5%. The number of usable responses was n=119 for Finland.

The 1290 Swedish questionnaires were sent by post to the Swedish companies on the first week of June 2006. Sixteen questionnaires were returned as undelivered bringing the sample size down to 1274. Responses for Sweden totaled 130, out of which 28 could not be used mainly due to missing data or the respondent being a subsidiary of a foreign multinational. Nearly, two thirds of the responses were received in the last week of June, which was also the week with the first responses. Most of the remaining responses arrived during the following two weeks. The number of usable responses was n=102. The response rate for Sweden (130/1274) was 10.2%, about 1% lower than for Finland. A response rate of about 10% is considered acceptable especially given the fact that no reminders were sent. Similar studies obtained comparable or even lower response rates

from the Nordic region (see, for example, Bagchi et al., 2007, Bagchi Skjoett-Larsen, 2005) and elsewhere (e.g. Li et al., 2006).

5.3 Survey design

The survey instrument was developed based on an extensive literature review in the relevant field: buyer-supplier relationships, SC integration, SCM and management accounting. For each latent variable (LV) in the model (Figure 3), multiple indicators were used, with a minimum of three indicators. Where possible, pre-tested instruments were used. The relevance and the wording of the measures were reviewed iteratively with the supervisors. A 7-point Likert scale was used for most of the LV's. The survey was then translated with the help of a professor into Finnish and Swedish, as this was believed to improve the response rate. Both versions (for Finland: Finnish and English; for Sweden: Swedish and English) were sent to the respective countries so that the respondent could select the desired language as well as to be able to cross check questions in case something was unclear. To make responding easier, the design and the wording of the survey was examined and improved iteratively. The next section presents detailed information about each variable in the survey.

5.4 Measurement of variables

5.4.1 Background variables

The first three questions in the questionnaire were designed to collect some useful background information about the respondent's company. The first question served to establish the position of the respondent in the supply chain. The categories consisted of raw material manufacturer, component manufacturer, final product manufacturer, wholesale/distributor, and retailer. Raw material extractors were excluded from the sample, as they do not have key suppliers. An "other" option was included in case a company did not fit into either of the categories. Question 2 helped to identify the industry of the respondent. Industry classifications were made according to the Global

Industry Sector Classification, which is also used by the Helsinki Stock Exchange. Thus, all the major industry categories such as automotive, material, retailing, capital goods, and technology were included (see questionnaire in Appendix 1 for a complete list). Question 3 facilitated the collection of additional facts about the respondent company. These were annual turnover, number of products sold, percentage of key suppliers over total suppliers, and return on invested capital (ROI). In the next question (Question 4), the respondent was asked how much information it provided to key suppliers (upstream information). The question is presented below together with the individual items, which were mainly adopted from Straub et al. (2004). These 9 items capture the specific type of information companies can exchange in a supply chain (which the information sharing scale in Question 9, to be presented, does not capture). A 7-point Likert scale was used to capture the responses. Items were coded from 1=none to 7=extensive. Items f, h, and i were only applicable to manufacturers and were therefore notated with "if applicable" in brackets.

4. How much information does your company provide to its key suppliers?
a) We give our key suppliers demand forecast information.
b) We give our key suppliers customer information (e.g. point of sales data).
c) We give our key suppliers inventory level information.
d) We give our key suppliers promotion/campaign information.
e) We give our key suppliers access to our warehouse/transportation management system
f) We give our key suppliers product design plans. (if applicable)
g) We give our key suppliers R&D information/plans.
h) We give our key suppliers production plan information. (if applicable)
i) We give our key suppliers production capacity information. (if applicable)

Question 5 asked the respondents what types of information systems their companies use to share information with their key suppliers. Regarding information systems, the emphasis was placed on advanced communication methods such as EDI and ERP (Carr and Kaynak, 2007). Two other communication systems were added, i.e. private web portals and supplier relationship software, which served to replace "computer to computer links" from Carr and Kaynak (2007). A free text field titled "other" was included in case the respondent used traditional communication methods such as telephone, fax, e-mail, and face-to-face communication (Carr and Kaynak, 2007) and/or

wished to add an unmentioned method. Question 6 requested the respondent to indicate the supply chain practices used to collaborate with key suppliers. The items were taken from Olhager and Selldin (2004): CPFR, SCP, VMI, and APS. Again, an empty text field allowed for the respondent to provide a practice not mentioned in the questionnaire.

5.4.2 Company performance

Generally, a single supply chain performance measure is inadequate since it is not inclusive (Beamon, 1999). Therefore, performance improvement due to information sharing of the focal company was measured according to Beamon (1999) and Cassivi et al. (2004) in Question 7 of the questionnaire. The measures consisted of three dimensions representing resource measures, output measures, and flexibility measures. The wording for the question was taken from Bagchi and Skjoett-Larsen (2005) and Bagchi et al. (2007). Performance improvement dimensions consisted of resource (a, b, c, d, f), output (e, g, h, j, m) and flexibility (i, k, l) as measures. A 7-point Likert scale was used to capture the responses. Items were coded from 1=no improvement to 7=extensive improvement.

7. How would you estimate your company's performance improvement after providing company information (demand forecasts, inventory, R&D plans, etc.) to your key suppliers?
a) Inventory turnover
b) Equipment utilization
c) Energy use
d) Operational costs
e) Stock out costs
f) Personnel requirements
g) Fill rates
h) On-time delivery
i) Flexibility to deliver
j) Product quality
k) Product variety
l) New product introductions
m) Customer satisfaction

5.4.3 Supplier dependence

Key suppliers' dependence on the respondent company was captured in question 8. The variables included the cost of switching to a new buyer, the effort of switching to a new buyer, and the level of asset specific investments by key suppliers into the exchange relationship. The items were adapted from Straub et al. (2004) and were incorporated into the questionnaire in the following way. A 7-point Likert scale was used to capture the responses. Items were coded from 1=disagree to 7=agree.

8. Please indicate how dependent your key suppliers are on your company by expressing your opinion on the following statements.
a) Our key suppliers will incur high costs (lost sales) if we switch to a new supplier.
b) Our key suppliers will incur high costs in human effort (searching) if we switch to a new supplier.
c) Our key suppliers have made specific investments into machinery or procedures to supply the products.

5.4.4 Demand uncertainty

The level of demand uncertainty faced by the focal company was established in Question 9 of the questionnaire using a scale developed by Ho et al. (2005). The scale was very comprehensive with 10 items covering the demand as well as the production mode of the company, which in turn affects demand. To give an example, when a company has short product life cycles (item 9b), demand is relatively harder to estimate, as the experience with the product is small. Similarly, long product to market cycles (9f) add to uncertainty, as demand becomes a function of future demand, with uncertainty increasing the further away into future. A 7-point Likert scale was used to capture the responses. Items were coded from 1=disagree to 7=agree.

9. Please indicate how much you agree with the following statements.
a) Our company has a high rate of new product introductions.
b) It is hard to predict product demand.
c) Our company's products have short life cycle times.
d) Our company has a large product variety.
e) Our company has a large number of sales channels.
f) Our company's products have long product to market cycle times.
g) Received orders are made very frequently.
h) Changes in order content are very frequent.
i) Orders are expedited frequently causing changes in order processing and production schedules.
j) The lead times of our company's products are long.

5.4.5 Buyer dependence

Question 10 was intended to capture the respondent company's level of dependency on its key suppliers. The variables were taken from Straub et al. (2004) and applied to this context. A 7-point Likert scale was used to measure the responses. Items were coded from 1=disagree to 7=agree.

10. Please indicate how dependent your company is on your key suppliers by expressing your opinion on the following statements.
a) Our company will incur high costs (e.g. searching, contracting) if we switch to a new supplier.
b) Our company will incur high costs (e.g. searching, contracting) in human effort if we switch to a new supplier.
c) Our company has made specific investments into machinery or procedures to process the purchased product.

5.4.6 Information sharing

In Question 11 information sharing between the focal company and its key suppliers was measured with 7 indicators adopted from Li et al. (2006). This scale differed from Question 4 measuring upstream information with regard to two factors; this scale measured mutual information sharing as opposed to upstream information only. Second,

the scale was more on a general level. A 7-point Likert scale was used to measure the responses. Items were coded from 1=disagree to 7=agree.

11. What is the information sharing policy between your company and its key suppliers?
a) We share our business units' proprietary information with suppliers.
b) We inform key suppliers in advance of changing needs.
c) Our key suppliers share proprietary information with us.
d) Our key suppliers keep us fully informed about issues that affect our business.
e) Our key suppliers share business knowledge of core business processes with us.
f) We and our key suppliers exchange information that helps establishment of business planning.
g) We and our key suppliers keep each other informed about events or changes that may effect the other partners.
h) How large is the strategic risk (loss of business opportunities) for your company in providing information on its business to its partners?

Item 11h, which can be considered a subsection, directly measured the risk of sharing private information with key suppliers (coding changed as 1=small and 7=large). In connection with this subject, a further question (Question 12) asked the respondent if the company would be willing to share more information in the future.

5.4.7 Environmental uncertainty

Environmental uncertainty was measured according to Hoque and James (2000) in Question 13. A 7-point Likert scale was used to capture the responses. Items were coded from 1=predictable to 7=unpredictable.

13. Please indicate the level of external environmental uncertainty for your company.
a) Supplier's actions (prior collaboration)
b) Customer demands, tastes and preferences
c) Deregulation and globalization
d) Market activities of competitors
e) Production and information technologies
f) Government regulation and policies
g) Economic environment
h) Industrial relations

5.4.8 Risk of opportunism

The risk of opportunism was measured by the product life cycle stage of the company. It follows the reasoning that companies in the earlier stages of the product life cycle are more vulnerable to opportunism and spillovers as the products have not taken off fully. The measure was taken from Hoque (2000). A percentage scale was used to measure the responses, which were to add up to 100 percent, when answered. Finally, item 15 in the survey provided a text box for the respondent to provide any comments regarding the survey.

14. Given below are descriptions of four alternative stages of the product life cycle.
Considering all the products of your firm, please indicate below the percentage of products that are at the following stages.
a. Emerging (a new product has recently been launched on the market: currently sales are low and prices are relatively high)
b. Growth (a product that has increasing sales due to increasing demand)
c. Mature (a product that provides stable income, neither increasing or declining sales while prices remain low)
d. Declining (profits and sales are declining due to declining interest by consumers)

5.5 The method for hypotheses testing

Partial Least Squares (PLS) Modeling was used to test the hypothesized relationships proposed in the study. The study was explorative and therefore a factor analysis was performed first to check for dimensionality in the scales. Scales were then adjusted according to the results of the factor analysis and subsequently used in PLS. A similar two-staged level procedure was used by Chenhall (2005).

PLS is a structural equation modeling (SEM) technique that is related to canonical correlation, principal component analysis, and Ordinary Least Squares regression (OLS). PLS has a number of advantages over covariance-based techniques such as LISREL and AMOS. The main advantage of PLS is that it has fewer restrictions on the data (Smith and Langfield-Smith, 2002). PLS requires a relatively small sample size: 30

– 100 compared to 200 – 800 for covariance based techniques (Chin, 1998). PLS is not sensitive to deviations from normality and does not make assumptions regarding the joint distributions of the indicators or the independence of observations (Bollen, 1989). A further advantage of PLS is that it allows for the modeling of reflective and formative indicators. Reflective indicators are caused by the latent variable, whereas formative indicators cause the latent variable. Reflective indicators have been widely used in research although not always correctly. There are numerous examples where formative indicators were incorrectly modeled as reflective. Formative indicators were first introduced by Blalock (1968) and researchers are starting to distinguish between them. This study used both types of latent variables. For example, whereas the intensity of information shared with key suppliers was set as reflective, the multidimensional uncertainty LV's were modeled as formative.

PLS avoids two serious problems: inadmissible solutions and factor indeterminancy. PLS avoids the first problem by not making rigid assumptions concerning data distributions. Factor indeterminancy is prevented, as factors consist of a series of OLS regressions thereby avoiding problems associated with recursive models.

PLS uses a three-stage estimation algorithm to obtain the weights, loadings, and path estimates. The first stage involves the estimation of the weights, which are necessary for the estimation of latent variable scores. The second stage generates estimates for the inner (structural relations among latent variables) and outer model (reflective or formative measurement paths). Finally, the third stage provides the means and location estimates (Ylinen, 2004). The PLS algorithm performs two estimations iteratively: an initial approximation and an inner approximation. The outside approximation is comparable to a principal component analysis, where weights of indicators are scaled to best capture the variance in the latent variable. The inner approximation estimates the path relations with each latent variable. When one-to-many or many-to-many relationships exist between latent variables, which is the case in complex SEM models, estimations are based on neighboring latent variables. Different procedures for combining neighboring latent variables exist (centroid, factor, and path weighting) but the path-weighting scheme (default in PLS-Graph 3.0) is the only procedure that takes

into account the directionality of the structural model (one-tailed tests) (Ylinen, 2004). Hence, the path-weighting scheme was used in this study.

5.6 Summary

This chapter dealt with sample selection, survey design, measurement of variables, and the method for hypothesis testing. The survey sample was selected from the largest manufacturing companies in Finland and Sweden. In total, close to 2500 mail questionnaires were sent in Spring 2006. The response rate was about 11% with usable responses totaling 221. The measures for variables in the questionnaire were borrowed from previous studies, where they have been found to work successfully. This chapter also presented PLS: the method used for hypothesis testing. The main advantage of PLS is the smaller restrictions on the data.

6 Data Analysis and Results

6.1 Introduction

This is the chapter where the data obtained through the survey is analyzed. Section 6.2 presents descriptive statistics for Finland and Sweden. Differences between countries are demonstrated through a comparison in the subsection 6.2.3. Next, the results of the factor analysis are given first for each country, and subsequently for the two countries. Hypotheses are tested in section 6.4 using partial least squares modeling. Consistent with the previous two sections, the results for Finland are presented first, followed by Sweden and last, the model is evaluated with the data combined. Finally, section 6.5 summarizes and concludes the chapter.

6.2 Descriptive statistics

6.2.1 Descriptive statistics Finland

Non-response bias was checked using t-statistics for independent samples. The sample was divided according to early and late respondents. The cut off point was at the end of the second week, which allowed the remaining five weeks to be identified as the period of late respondents. Non-response bias was not found according to a 95% confidence interval.

The distribution of the companies according to their position in the supply chain is illustrated in Figure 4. As illustrated in Figure 4, almost half of the Finnish companies (58 out of 119) were final product manufacturers. The wholesale/distributor category was the second largest with 30 companies.

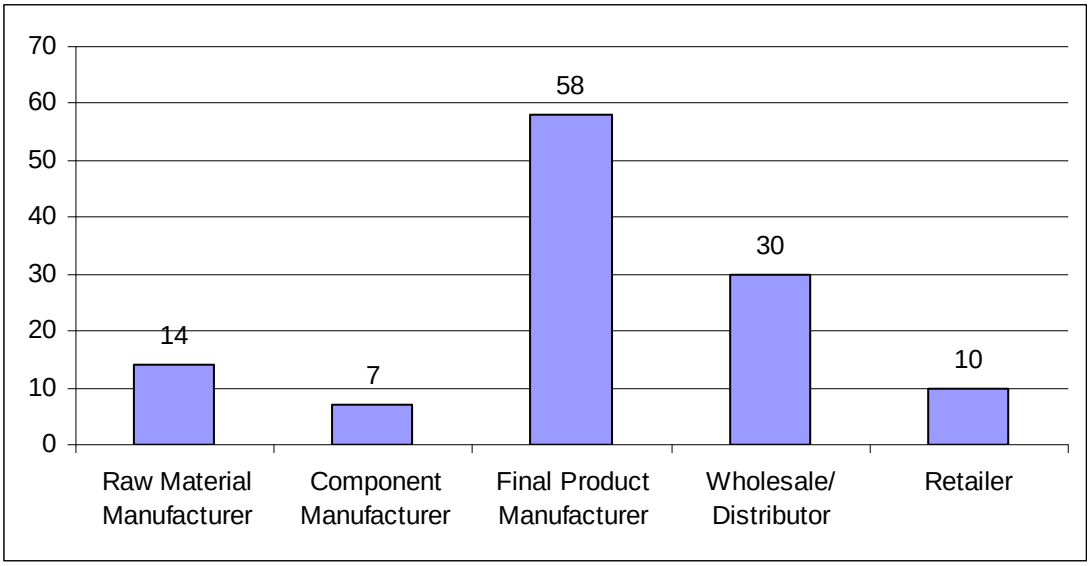

Figure 4: Position in the supply chain - Finland

The industries of the respondent companies are shown in Figure 5. About a quarter of the companies (30 out of 119) were in the materials industry. Capital goods and technology ranked second (22) and third (14) respectively. Companies in multiple industries, or where the industry was not known, totaled 14.

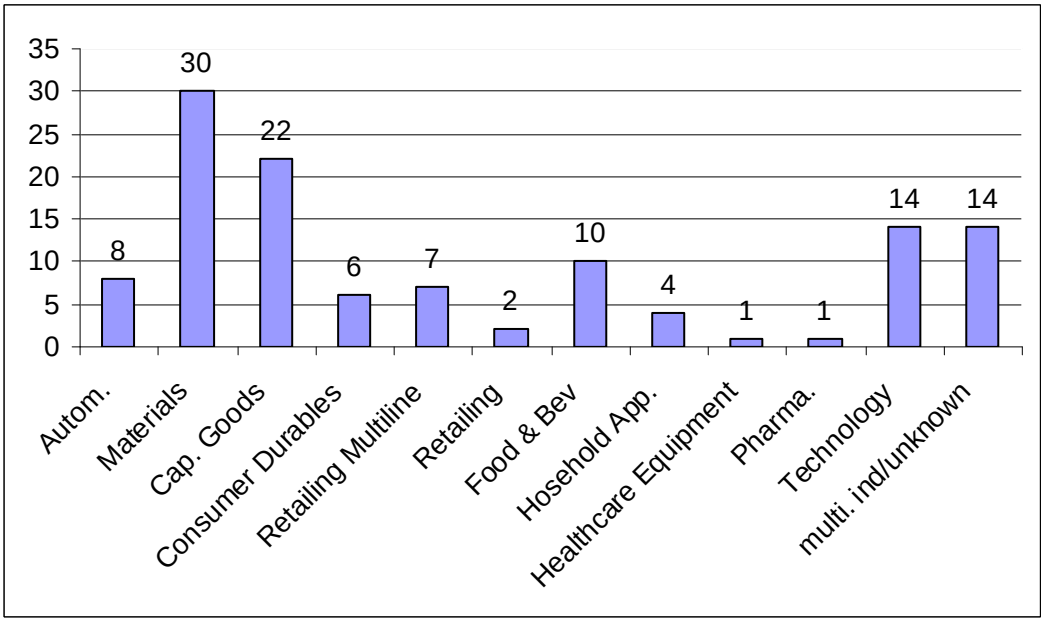

Figure 5: Industry - Finland

Turnover in million EUR of the respondent companies is shown in Figure 6. The distribution for the middle categories was similar. The category representing smaller companies (49 to 15 million EUR) accounted for nearly half the responses.

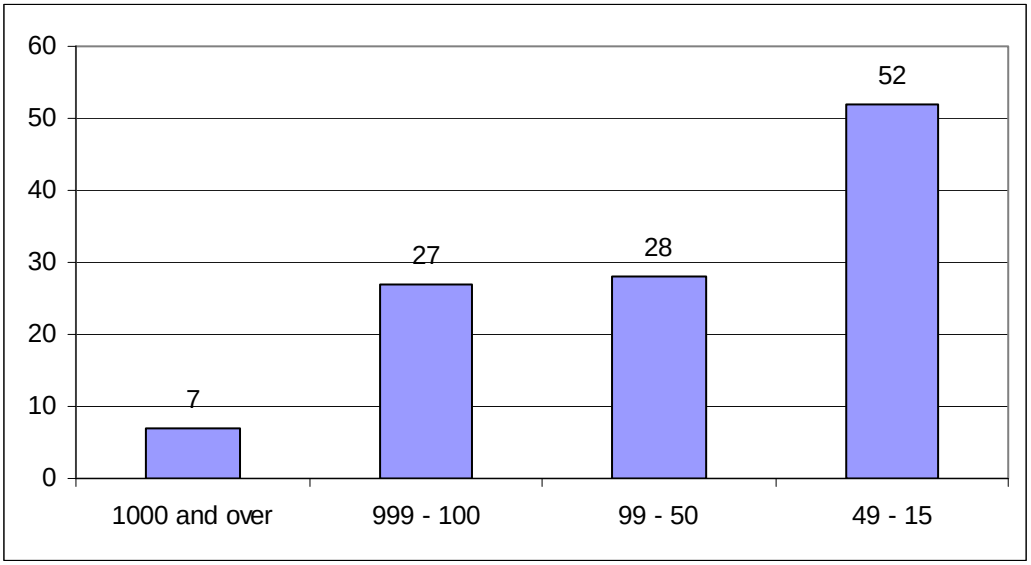

Figure 6: Turnover in million EUR - Finland

Regarding the ratio of key suppliers to non key suppliers (Question 3c), on average, 53% of suppliers were regarded as key suppliers. Figure 7 presents percentages for communication methods by the Finnish companies. EDI, ERPS, and Web portals were the dominant communication methods, with around 40%. SRM software was less utilized for information sharing. These results were not surprising since previous studies indicated that a substantial number of companies adopted ERP systems (e.g. Kemppainen and Vepsäläinen, 2003, Patterson, Grimm, and Corsi, 2004). Regarding Web portals, they were also widely used as they are relatively easy to set up and cost efficient. Also EDI using dedicated networks or the Internet is a relatively mature technology, whereas SRM software are newer and more specialized, which might explain the relatively low adoption rate. There were also a significant number of companies that indicated the use of traditional methods, which might still be perceived as a more effective and fast way of communication. The actual usage rate of traditional communication methods is possibly much higher than indicated in the responses, as this was not specifically asked in the survey.

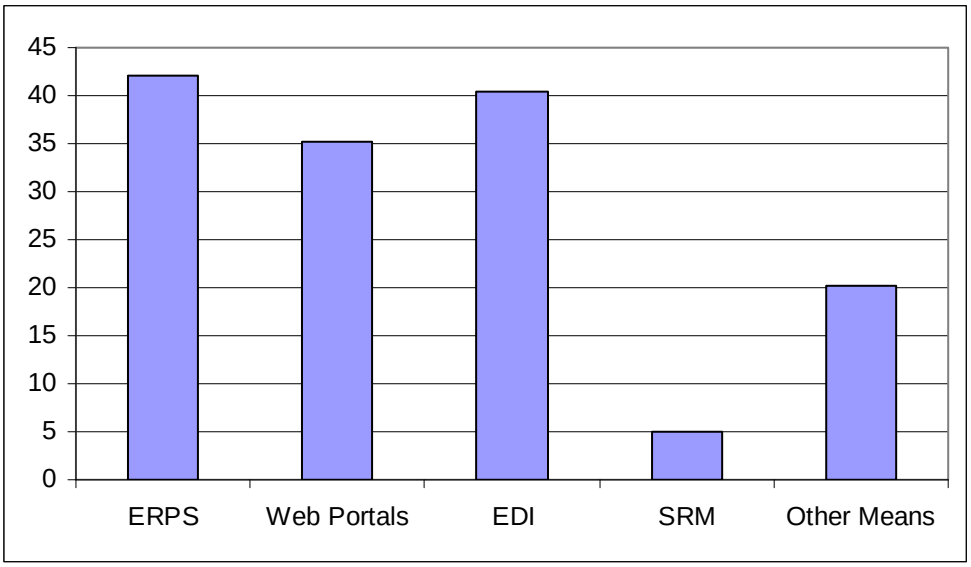

Figure 7: IT usage for information sharing in percentage - Finland

ERPS: Enterprise Resource Planning Systems
EDI: Electronic Data Interchange
SRM: Supplier Relationship Software
Other Means: Refers to more traditional ways of communication: i.e. telephone, fax, and meetings

Figure 8 shows percentages for the adoption of supply chain practices. SCP was widely used (slightly above 40%) followed by VMI. SCP is a somewhat vague term and can cover many of the practices discussed in Chapter 3. This might explain the high usage percentage. CPFR and APS are more specific practices, which might explain the relatively low usage percentages.

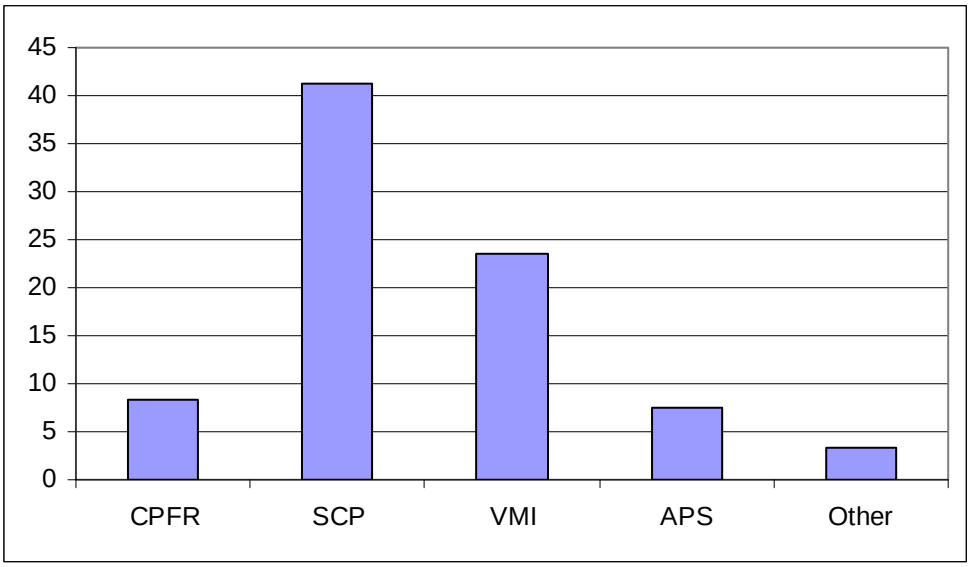

Figure 8: Supply chain practices in percentage - Finland

CPFR: Collaborative Planning, Forecasting and Replenishment
SCP: Supply Chain Planning
VMI: Vendor Managed Inventory
APS: Advanced Planning and Scheduling
Other: e.g. fax, e-mail

The intensity of upstream information flow is shown in Table 4. The sample only covers manufacturers (n=79), as the lower three items (product design, production, and capacity) were not applicable to wholesalers and retailers. The mean scores for demand forecast and production plan information were fairly high, indicating that buyers provided substantial information to their key suppliers on the mentioned items. This was expected as demand information is highly valuable and relatively less risky to share. Access to warehouse/transportation systems had the smallest mean, which might be a matter of a lack of necessity. Standard deviations for design and production plan information were relatively high indicating that there were significant differences between firms.

Table 4: **Upstream Information Flow - Finland**

Factors	Item Mean Scale 1-7	Stand. Dev.
demand forecasts	4.81	1.48
production plans	4.28	1.86
production capacity	4.13	1.81
inventory	4.08	1.72
design	3.82	1.92
R&D	3.54	1.75
promotion/campaign	3.42	1.81
customer	2.35	1.44
warehouse/transp.	1.89	1.40

6.2.2 Descriptive statistics Sweden

Non-response bias was checked using t-statistics for independent samples. The sample was divided according to early and late respondents. The cut off point was at the end of the second week, which allowed the remaining five weeks to be identified as the period of late respondents. Non-response bias was not found according to a 95% confidence interval.

The distribution of the companies according to the position in the supply chain is illustrated in Figure 9. As illustrated in Figure 9, almost half of the companies (47 out of 102) were final product manufacturers. The wholesale/distributor category was the second largest (24 companies), closely followed by component manufacturers (19 companies). Raw material manufacturers represented the smallest group.

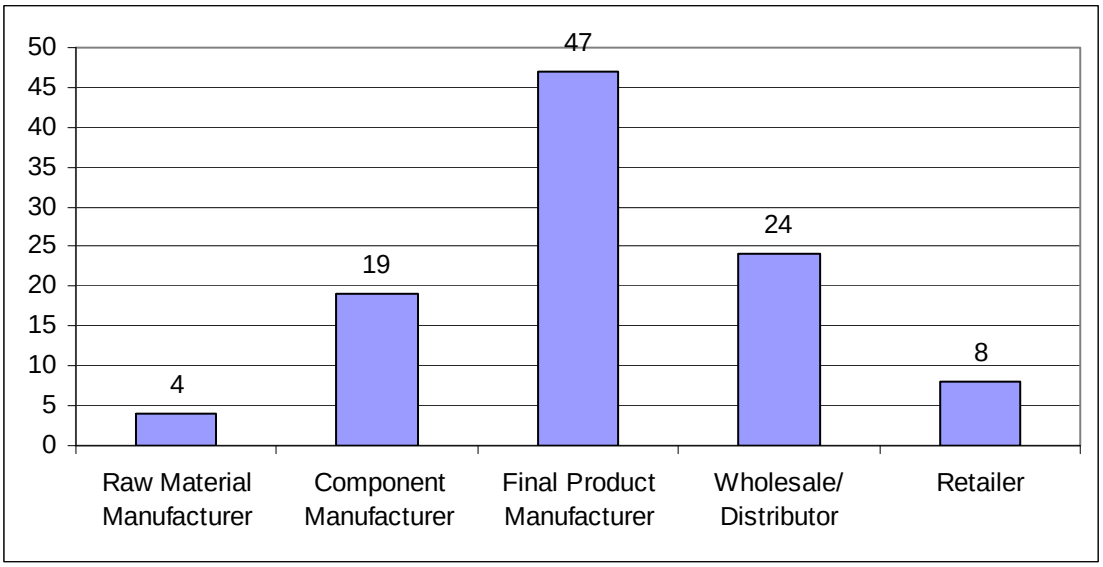

Figure 9: Position in the supply chain - Sweden

The industries of the respondent companies are shown in Figure 10. Materials, capital goods and technology categories included the most companies. Consumer durables represented the smallest category with only one company.

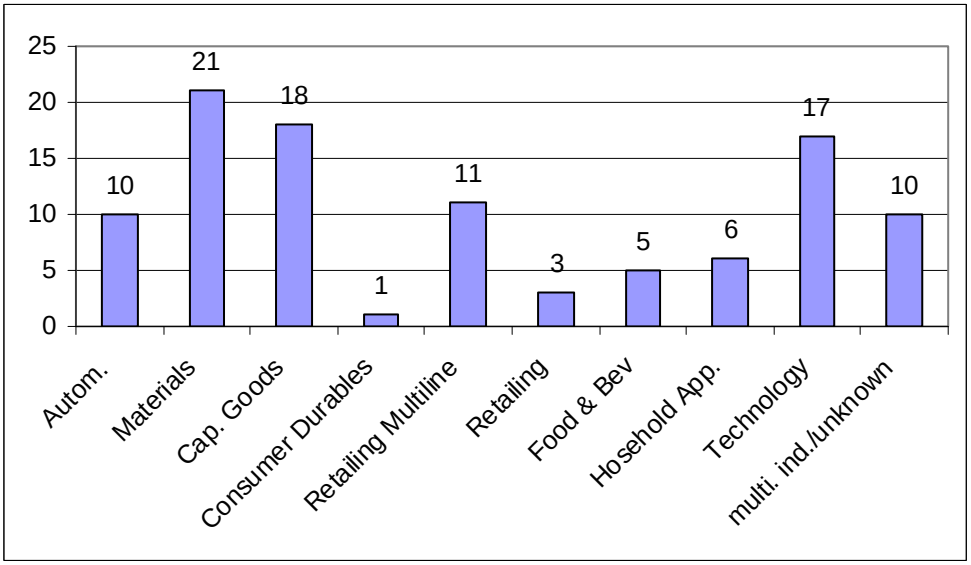

Figure 10: Industry - Sweden

Turnover in million EUR of the respondent companies is shown in Figure 11. The distribution for the middle categories was similar. The category representing smaller

companies (49 to 15 million EUR) accounted for slightly more than half of the responses.

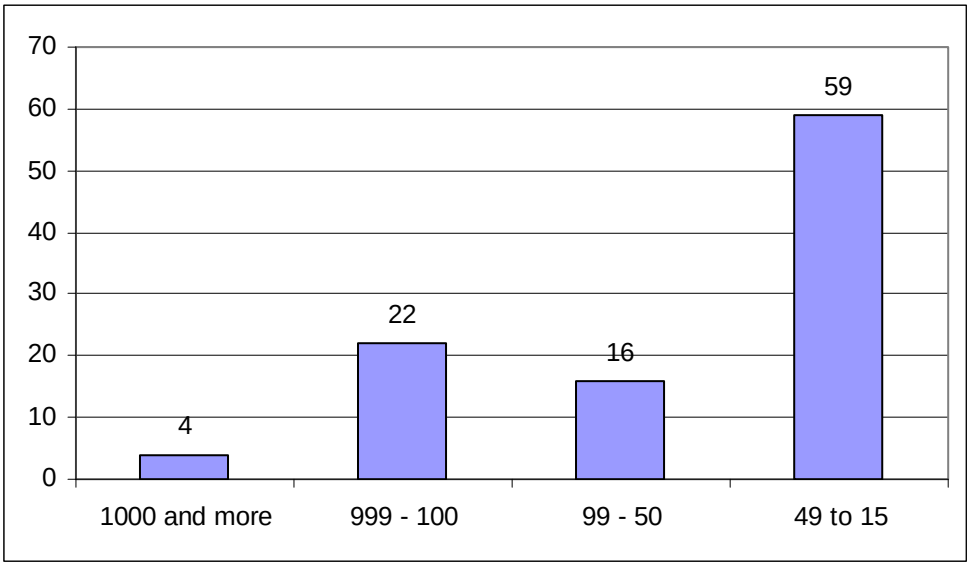

Figure 11: Turnover in million EUR - Sweden

On average, 27% of suppliers were key suppliers (Question 3c), which was smaller than for Finnish companies. Figure 12 presents usage percentages of IT by the Swedish companies. EDI and other means were the largest categories – close to 40%. ERP systems and Web portals were less utilized for information sharing, whereas SRM applications were almost not implemented at all.

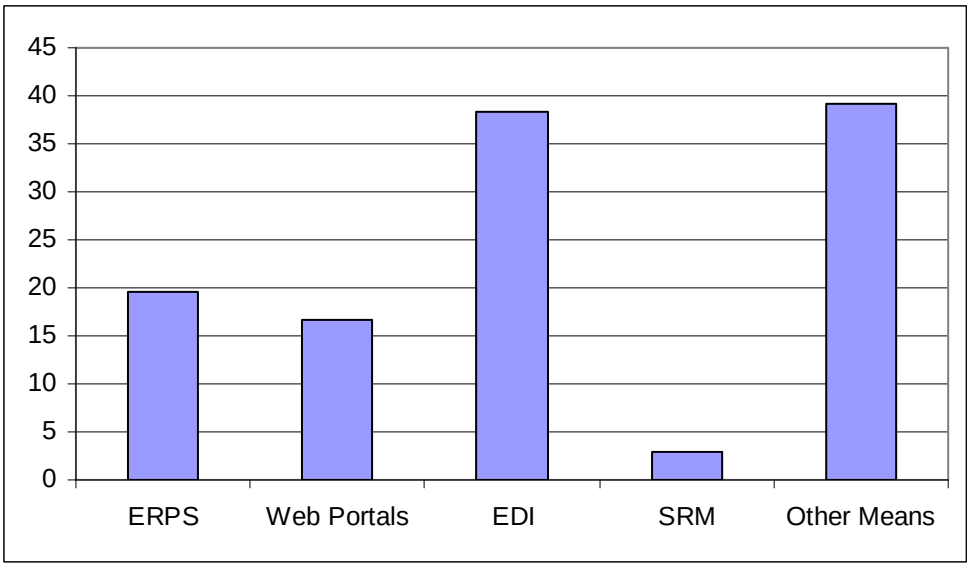

Figure 12: IT usage for information sharing in percentage - Sweden

Figure 13 shows percentages for the adoption of supply chain practices. Generally, none of the practices in the survey were widely used (below 25%). Nevertheless, VMI and SCP were the most common among the practices.

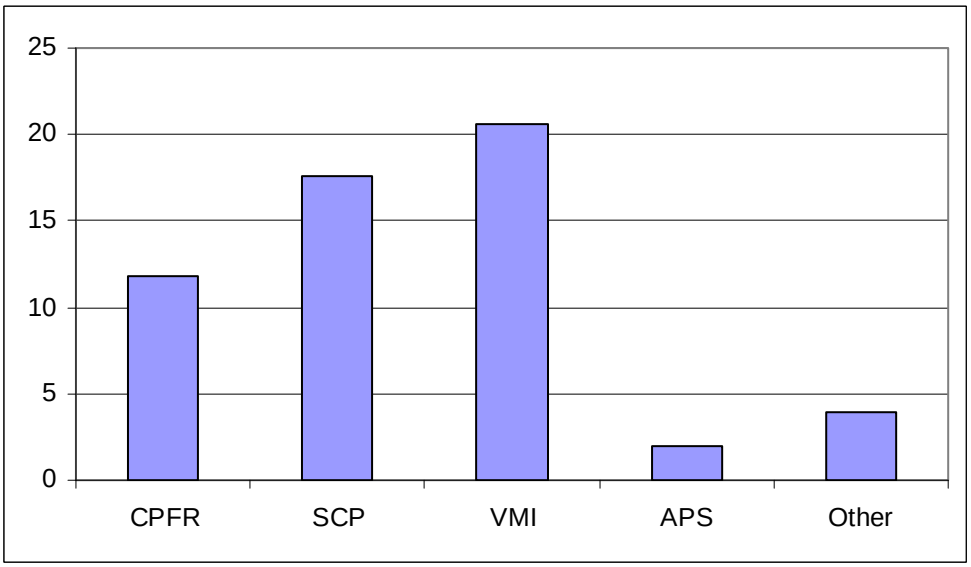

Figure 13: Supply chain practices in percentage - Sweden

Table 5 presents upstream information flow for manufacturing companies (n=70). Demand forecast information had the highest mean followed by production plans and production capacity. Information on product design and warehouse/transportation was

least provided. Standard deviations for the means of promotion/campaign and warehouse/transportation were relatively high indicating that significant differences existed between firms.

Table 5: Upstream information flow - Sweden

Factors	Item Mean Scale 1-7	Stand. Dev.
demand forecast	5.61	1.27
production plan	4.71	1.66
production capacity	4.53	1.82
product design	4.50	1.85
inventory	4.13	1.74
R&D	3.42	1.74
promotion/campaign	2.81	1.88
customer	2.77	1.57
warehouse/transp.	2.53	1.87

6.2.3 A comparison of Finnish and Swedish Responses

Figures 14 and 15 illustrate the usage of supply chain technologies and practices in Finland and in Sweden. With respect to the usage of technologies, Finnish respondents had clearly an advantage. Regarding supply chain practices, the differences were smaller, although they were somewhat in favor of Finland. The most used practices were supply chain planning and VMI.

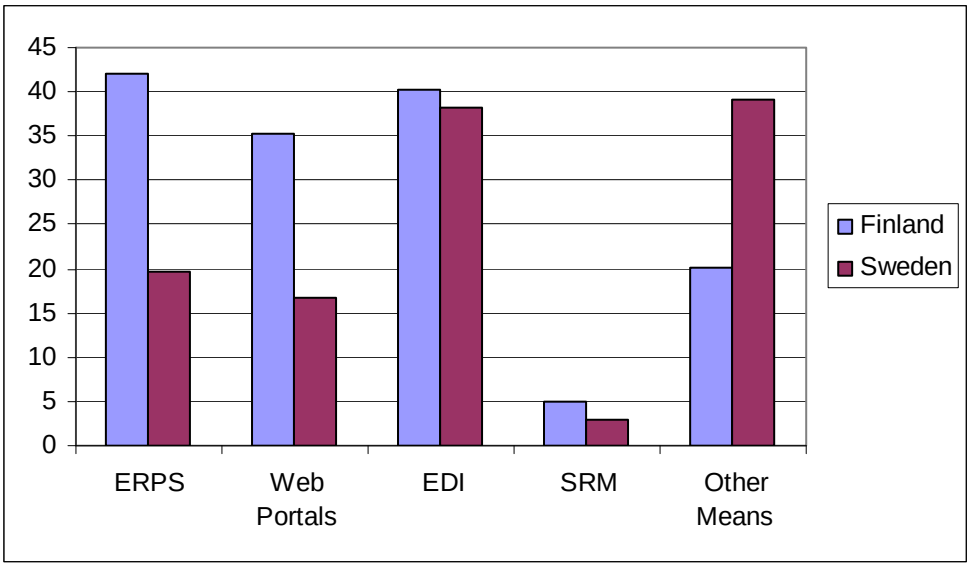

Figure 14: A comparison of technologies used in information sharing

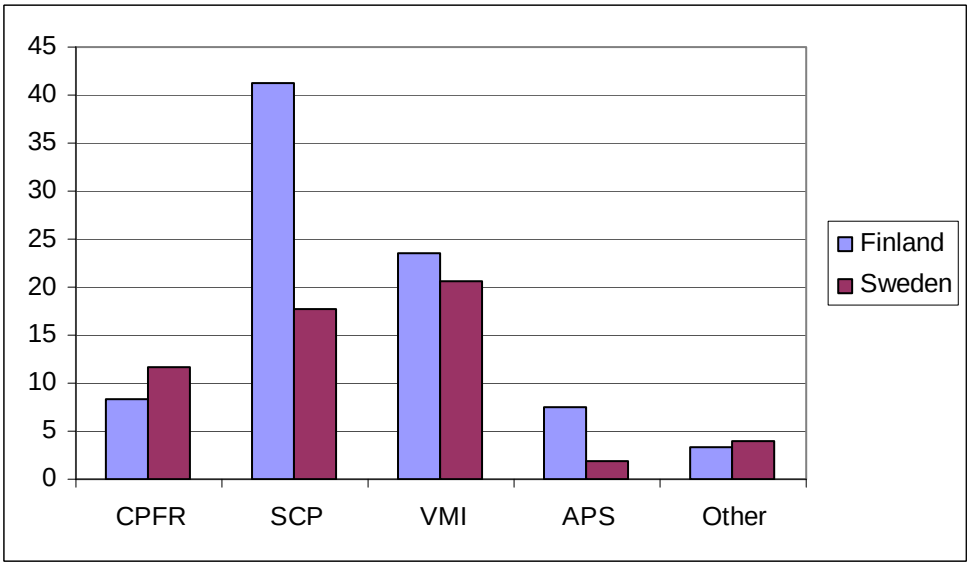

Figure 15: A comparison of supply chain practices among Finnish and Swedish Respondents

Regarding upstream information provided to key-suppliers, the trends were similar between countries except for demand forecast information, which was relatively high in Sweden. T-tests for the two independent samples indicated that information shared on demand forecasts is significantly different in the two countries.

Table 6: Upstream Information Flow Compared

	Finland Mean Scale: 1-7	**Sweden Mean**	**significance**
demand forecasts	4.81	5.61	**
production plans	4.28	4.71	no
production capacity	4.13	4.53	no
inventory	4.08	4.13	no
design	3.82	4.50	no
R&D	3.54	3.42	no
promotion/campaign	3.42	2.81	no
customer	2.35	2.77	no
warehouse/transp.	1.89	2.53	no

** significant at $p<0.01$

6.3 Factor analysis

6.3.1 Factor analysis of Finnish Reponses

Exploratory and confirmatory (where applicable) factor analyses were performed for the reflective constructs (information sharing, buyer -, supplier dependency and performance). All factor analyses were based on the principal axis factoring – direct oblimin rotation method. Oblimin rotation was used as high correlations between indicators were expected and later found. Only components with an Eigenvalue above 1.0 were included. Pairwise deletion for missing values was used and no large outliers were found in the data, which could skew the results. This was verified by comparing the 5% trimmed mean values with the non-trimmed mean values, which were very close (Pallant, 2004).

Although, the dimensions for the performance measures were known from Cassivi et al. (2004), an exploratory factor analysis on all the items in the three dimensions was performed to explore the data. This had not been done in the previous studies where the measures were developed and tested. The results are presented in Table 7. The correlations between the items are shown in Appendix 3. The items were highly correlated.

Table 7: **Factor Analysis - Performance - Finland - Exploratory**

Factors	**Loading**	**Variance Expl.**	**Cronbach**	**Item Mean Scale: 1-7**	**Stand. Dev.**
Output		48%	0.912		
on-time del.	0.921			5.10	1.49
flex. to del.	0.809			5.18	1.37
stock-out costs	0.750			5.02	1.45
oper. costs	0.683			4.30	1.36
cust. satisf.	0.673			4.92	1.56
inv. turnover	0.504			4.58	1.47
fill rates	0.465			4.15	1.68
Flexibility		7%	0.748		
prod. variety	0.799			3.53	1.68
new prod. intro.	0.660			3.89	1.68
personnel requirem.	0.327			3.19	1.55
Resource		5%	0.704		
energy use	0.808			2.43	1.29
equipm. utiliz.	0.574			3.47	1.48
prod. quality	0.394			3.84	1.63

KMO: 0.90, Barlett’s Test: significant

The factor analysis resulted in three components, consistent with the number of underlying dimensions (resource, output, flexibility). However, the indicators were not exactly clustered as according to the given dimensions. All the indicators loaded well on the constructs and scale reliability (Cronbach’s alpha) was above the minimum 0.6 level. Scale reliability over 0.6 is sufficient for exploratory studies, whereas a minimum of 0.7 is acceptable for confirmatory studies (Fornell and Larcker, 1981). The Kaiser-Meyer-Olkin Measure of Sampling was adequate and Bartlett's test of sphericity was significant, which indicate that the data was appropriate for factor analysis. The mean scores for on-time delivery, flexibility to deliver, and stockout costs were particularly high, indicating that a substantial improvement on the said items have been estimated by companies as a result of supply chain information provided. Also, confirmatory factor analysis based on Beamon (1999) on the 3 dimensions of the performance measures was performed. The results were also satisfactory and are presented in Appendix 2. Next, a factor analysis for supplier dependency was performed. As illustrated in Table 8, the factors loaded well and the Cronbach’s alpha was high.

Table 8: **Factor Analysis - Supplier Dependence - Finland**

Factors	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Supp. Depend.		66%	0.828		
monetary costs	0.960			4.15	1.74
search costs	0.869			3.89	1.76
specific investm.	0.542			3.66	1.73

KMO: 0.63, Barlett's Test: significant

For demand uncertainty, no factor analysis was required as the construct was set as formative. This was the case as the indicators forming the construct had possibly different antecedents and did not necessarily correlate, e.g. the number of sales channels and the lead times of the products. Nevertheless, to support this preposition, factor analysis was performed, which resulted in 3 components indicating the multidimensionality of the data (see Appendix 2). Ho et al. (2005), who developed the construct, found four components in an explorative factor analysis with the same indicators, which they labeled as channel characteristics, product characteristics, demand forecast and, demand change. However, Ho et al. (2005) later in the study used the 10 indicators to reflect the demand uncertainty latent variable, where the results were satisfactory. The correlation matrix in Appendix 3 shows that the items were not highly correlated, which also supports the argument that the indicators are formative rather than reflective.

Factor analysis on buyer dependency resulted in one component. One indicator, specific investments into machinery or procedures, was dropped as it loaded low on the construct. The scale reliability for the construct was high.

Table 9: Factor Analysis - Buyer Dependence - Finland

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Buyer Depend.		56%	0.893		
monetary costs	0.991			4.43	1.54
search, contr. costs	0.811			4.16	1.55

KMO: 0.85, Barlett's Test: significant

Factor analysis on information sharing returned one component with high loadings and good reliability (Table 10). The correlations between the items are shown in Appendix 3. The items were highly correlated.

Table 10: Factor Analysis - Information Sharing -Finland

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Inf. Sha.		49%	0.868		
processes	0.792			4.25	1.39
informed	0.724			4.04	1.52
proprietary (1)	0.695			3.74	1.65
proprietary (2)	0.690			3.98	1.36
issues	0.688			4.87	1.15
needs	0.676			5.30	1.20
planning	0.642			4.13	1.45

KMO: 0.79, Barlett's Test: significant

Environmental uncertainty as a construct was perceived as being formed by the underlying indicators. Hoque (2004) used the indicators as reflective although the indicators did not need to have common antecedents, e.g. uncertainty in production and information technologies and market activities of competitors. The correlation matrix in Appendix 3 shows that the items correlated weakly, which supported this claim.

6.3.2 Factor analysis of Swedish Responses

Factor analysis for performance returned 3 components with good loadings and high Cronbach's alphas (Table 11). Item means for on-time deliveries, customer satisfaction, and flexibility to deliver, indicate relative strong improvements in the mentioned areas.

Table 11: Factor Analysis - Performance - Sweden - Exploratory

Factors	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Output		41	0.872		
on-time del.	0.832			5.33	1.53
flex. to del.	0.672			4.95	1.52
cust. satisf.	0.644			4.96	1.66
fill rates	0.637			4.44	1.65
inv. turnover	0.627			4.26	1.55
stock-out costs	0.503			3.97	1.63
personnel requirem.	0.422*			3.14	1.55
Resource		12	0.811		
energy use	0.882			2.25	1.51
oper. costs	0.746			2.74	1.55
equipm. utiliz.	0.600			3.03	1.55
Flexibility		8	0.881		
prod. variety	0.901			3.44	1.86
new prod. intro.	0.833			3.97	1.99
prod. quality	0.678			4.54	2.01

*discarded as it loaded high also on component 2
KMO: 0.82, Barlett's Test: significant

Satisfactory results were also obtained from factor analysis for the other reflective constructs: supplier- buyer dependency and information sharing (Tables 12 - 14). Hence, the results from the factor analysis permitted all three measures to be used.

Table 12: Factor Analysis - Supplier Dependence - Sweden

Factors	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Supp. Depend.		61%	0.78		
monetary costs	0.973			4.25	1.67
search costs	0.824			4.12	1.60
specific investm.	0.443			3.13	1.62

KMO: 0.60, Barlett's Test: significant

Table 13: Factor Analysis - Buyer Dependence - Sweden

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Buyer Depend.		55%	0.710		
monetary costs	0.921			4.09	1.54
search, contr. costs	0.787			4.56	1.53
specific investm.	0.432			4.74	2.01

KMO: 0.60, Barlett's Test: significant

Table 14: Factor Analysis - Information Sharing - Sweden

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean	Stand. Dev.
Inf. Sha.		51%	0.872		
planning	0.820			4.57	1.41
issues	0.802			4.41	1.56
informed	0.739			4.99	1.31
proprietary (2)	0.694			3.88	1.37
needs	0.688			5.16	1.40
processes	0.637			3.98	1.52
proprietary (1)	0.578			3.99	1.65

KMO: 0.85, Barlett's Test: significant

6.3.3 Factor Analysis of Pooled Data

A factor analysis was performed on the pooled sample (N=221) for the reflective constructs. For performance, the factor analysis with 13 indicators returned the following clusters in Table 15. Based on the clusters, a separate factor analysis for each dimension was performed subsequently to obtain variance explained and Cronbach's alpha. The results were satisfactory but surprising regarding the third construct (flexibility), which included product variety, introductions, and quality. All the three loadings were high but negative. This was not the case when the data was analyzed separately for each country. Thus, the combination of data from two separate countries (cultures) might explain this occurrence.

Table 15: Factor Analysis - Performance - Pooled Data

Factors	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Resource		42(50*)	0.787		
energy	0.816			2.35	1.40
equipment	0.670			3.28	1.53
operational	0.650			3.61	1.64
personnel requirem.	0.348			3.17	1.54
Output		9(55*)	0.878		
on-time	0.919			5.20	1.50
flexibility	0.745			5.07	1.44
satisfaction	0.660			4.94	1.60
fill rates	0.521			4.29	1.67
inventory	0.513			4.43	1.51
stock-out	0.484			4.54	1.62
Flexibility		5(59*)	0.801		
variety	-0.806			3.49	1.76
introductions	-0.760			3.93	1.83
quality	-0.592			4.17	1.90

KMO: 0.80, Barlett's Test: significant
* when FA was performed separately for an individual dimension

Relative to other items, on-time delivery, flexibility to deliver, and customer satisfaction scored highest. On the other hand, resource measures had relatively low means. Factor analysis on the remaining three measures provided satisfactory results as well. Thus this allowed for the data to be further analyzed using PLS.

Table 16: Factor Analysis - Supplier Dependence - Pooled Data

Factors	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Supp. Depend.		63	0.799		
monetary costs	0.970			4.20	1.70
search costs	0.845			4.00	1.69
specific investm.	0.484			3.41	1.70

KMO: 0.61, Barlett's Test: significant

Table 17: Factor Analysis - Buyer Dependence - Pooled Data

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Buyer Depend.		74	0853		
monetary costs	0.556			4.27	1.55
search, contr. costs	0.560			4.35	1.55
specific investm.*	0.075			3.44	1.90

KMO: 55, Barlett's Test: significant
* discarded

Table 18: Factor Analysis - Information Sharing - Pooled Data

Factor	Loading	Variance Expl.	Cronbach's Alpha	Item Mean Scale: 1-7	Stand. Dev.
Inf. Sha.		49	0.867		
issues	0.742			4.21	1.54
informed	0.732			4.93	1.22
planning	0.716			4.33	1.44
processes	0.704			4.13	1.46
proprietary (2)	0.690			3.94	1.36
needs	0.675			5.24	1.29
proprietary (1)	0.641			3.86	1.65

KMO: 0.85, Barlett's Test: significant

6.4 Structural Equation Modeling

6.4.1 Structural Equation Modeling with Finnish Responses

Partial Least Squares (version PLS-Graph 3.00) was used to test the hypothesized relationships. Correlations between latent variables are depicted in Table 19. Correlation coefficients were obtained in SPSS, where PLS weights for the indicators were used to compute LV scores. As expected, correlations of information sharing with the other variables were positive, significant and high (except for PLC), suggesting that the proposed hypotheses might hold. To assess discriminant validity of the constructs at this stage, the square root of average variance extracted (to be discussed in the next section), which is the correlation of the construct with its measures was compared to the

correlation of the construct with other constructs (Chin, 1998). The square root of AVE was required to be larger than the correlations with other constructs. This was the case for all constructs, indicating that the condition for discriminant validity was met. Average variance extracted (AVE) is not applicable to constructs with formative indicators as the indicators are not expected to correlate with each other (Diamantopoulos and Winklhofer, 2001).

Table 19: Correlations of latent variables - Finland

	InfoSha.	Resou.	Output	Flexib.	DemUn.	Supdep.	Buydep.	EnvUn.	PLC
InfoSha.	**0.750**								
Resou.	0.474**	**0.792**							
Output	0.624**	0.671**	**0.791**						
Flexib.	0.408**	0.522**	0.647**	**0.800**					
DemUn	0.369**	0.290**	0.299**	0.277**	NA				
Supdep.	0.312**	0.313**	0.410**	0.195*	0.126	**0.857**			
Buydep.	0.291**	0.141	0.245**	0.167	-0.053	0.239**	**0.948**		
EnvUn.	0.258**	0.223*	0.166	0.275**	0.118	0.054	0.073	NA	
PLC	0.112	0.111	-0.018	0.145	-0.047	0.74	0.089	0.078	NA

square root of AVE in diagonal for reflective constructs
** significant at the 0.01 level (2-tailed), * significant at the 0.05 level (2-tailed)
NA: Not applicable

Model

The model is shown in Figure 16. The model draws on the original model (Figure 3) in terms of the hypothesized relationships. The constructs were formed according to the factor analysis in section 6.3.1. Demand uncertainty and environmental uncertainty constructs were set as formative, whereas supplier dependency, buyer dependency, information sharing, and performance were set as reflective as discussed previously.

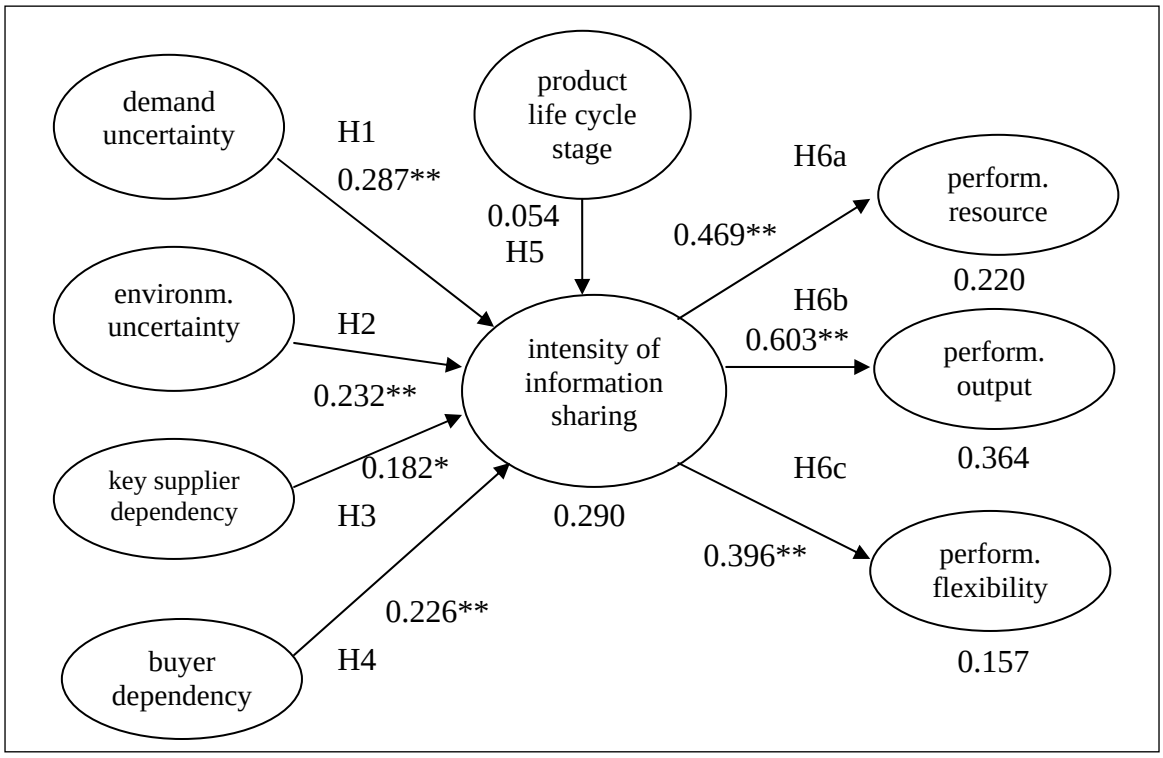

Figure 16: Model - Path coefficients and R squared - Finland
** significant at p < 0.01, * significant at p < 0.05

In PLS, the measurement model is evaluated according to item loadings, reliability coefficients, convergent, and discriminant validity. According to Fornell and Larcker (1981), item loadings exceeding 0.7 are considered adequate for reflective indicators. However, loadings above 0.5 are also accepted (Hulland, 1999). For formative indicators, the weights not the loadings are taken into consideration. Composite reliability, which is interpreted like Cronbach's alpha for internal consistency reliability is considered adequate when greater than 0.7 (Fornell and Larcker, 1981). AVE, a measure indicating how much the indicators explain the variance in the construct is acceptable when it exceeds 0.5 (Barclay, Thompson, and Higgins, 1995). Discriminant validity is assessed by verifying that items across constructs have minimum correlations than with the corresponding construct. This was verified through factor analysis.

The table in Appendix 4 (outer model - Finland) presents the results for the measurement (outer) model in terms of item loadings, weights, AVE, and composite reliability. All item loadings for the reflective indicators except product quality and

personnel requirements were satisfactory, exceeding 0.7. AVE and composite reliability were sufficient for all reflective constructs.

The strengths of the relationships (β's) are shown in Figure 16. In PLS, for testing the fit of the model, in addition to AVE values, t-statistics for the path coefficients must be checked. To this purpose, bootstrapping with 500 samples was generated. For one-tailed tests as in this case, values above 1.64 ($p < 0.05$) and 2.33 ($p < 0.01$) are considered to be significant. According to the t-statistics (see Appendix 4), all the relationships had a significant positive relationship with information sharing except for PLC. Also, information sharing was positively associated with performance 1, 2, and 3. Thus, hypothesis H1, H2, H3, H4, and H6 were supported. Regarding H5, an additional analysis was carried out to test for curvilinearity. However, the results showed no support for a such a relationship between PLC and information sharing.

The explanatory power of the model is determined by looking at average R squared of the endogenous variables, which was 0.258. This value was satisfactory when compared to similar studies in the field (e.g. Bagchi and Skjoett-Larsen 2005) and indicated that the model had predictive power.

6.4.2 Structural Equation Modeling with Swedish Responses

The same PLS analysis was carried out for the Swedish data. Table 20 shows the correlations between the latent variables. Information sharing, the central element of the model had a positive and strong to medium correlation with the other variables as expected (except for PLC). Discriminant validity was found to be satisfactory based on the fact that the square root of AVE values were larger than correlations.

Table 20: Correlations of latent variables - Sweden

	InfoSha.	Resou.	Output	Flexib.	DemUn	Supdep.	Buydep.	EnvUn.	PLC
InfoSha.	**0.756**								
Resou.	0.307**	**0.842**							
Output	0.404**	0.423**	**0.756**						
Flexib.	0.312**	0.336**	0.574**	**0.888**					
DemUn.	0.433*	0.148	0.105	0.132	NA				
Supdep	0.386**	0.254**	0.249**	0.288**	0.160	**0.948**			
Buydep	0.311**	0.127	0.057	0.165	0.047	0.417**	**0.817**		
EnvUn.	0.249*	0.009	-0.13	0.104	-0.150	0.166	0.420	NA	
PLC	0.085	0.118	0.224**	0.172	0.138	0.002	-0.037	-0.205**	NA

square root of AVE in diagonal for reflective constructs
** significant at the 0.01 level (2-tailed), * significant at the 0.05 level (2-tailed)
NA: Not applicable

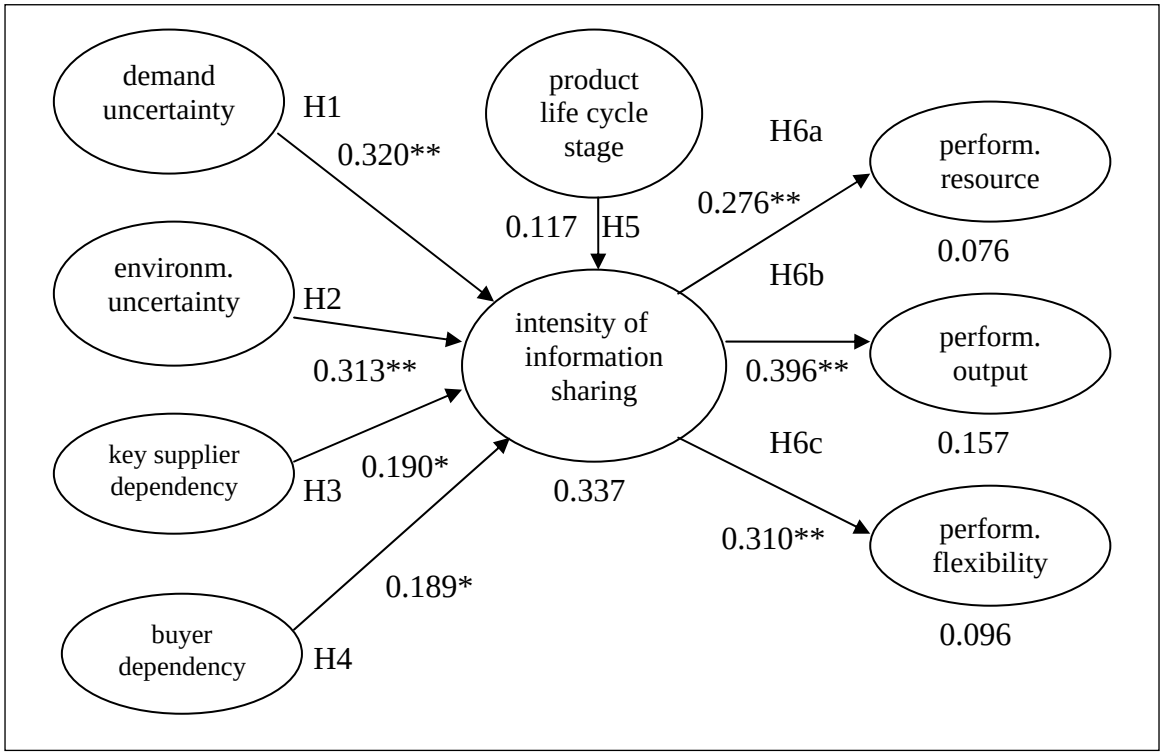

Figure 17: Model - Path coefficients and R squared - Sweden
** significant at $p < 0.01$, * significant at $p < 0.05$

The results for the model (path coefficients and R squared) are given in Figure 17. The values for loadings, weights, AVE, and composite reliability are shown in Appendix 4 (outer model - Sweden). The outer model performed well and the results gave support for all the hypotheses except H5: a very similar result compared to the Finnish sample. The average R squared was 0.166, considerably smaller than the Finnish sample but still satisfactory.

6.4.3 Structural Equation Modeling with Pooled Data

Since the results from the two samples were similar, it was appropriate to pool the data. Table 21 presents correlation values for the latent variables. As expected, correlations between information sharing and other variables were weak to moderate. Figure 19 displays the results from PLS. The results are similar to country specific results. All hypotheses were supported except for the relationship between PLC and information sharing. Appendix 4 (outer model – pooled data) shows the loadings, AVE, and composite reliability scores, which were above the minimum threshold and therefore satisfactory. This was expected. R squared for the first part (determinants) of the model was 0.22 and for the second part (consequences) 0.168, 0.226, and 0.112, where the average R squared was 0.182. Regarding the first part of the model, these values were clearly higher for the country specific values (Finland 0.34, Sweden 0.29). Hence, pooling the data lead to a loss in variance explained. For the second part of the model, R squared for the pooled data was an average of the values obtained for each country.

In PLS-Graph, it was also tested whether size, position, or industry explained the level of information sharing. To this purpose a new latent variable with one indicator was created that included categorical data. The results were insignificant.

Table 21: Correlations of latent variables - Pooled data

	InfoSha.	**Resou.**	**Output**	**Flexib.**	**DemUn.**	**Supdep.**	**Buydep.**	**ExtUn.**	**PLC**
InfoSha.	**0.749**								
Resou.	0.440**	**0.775**							
Output	0.502**	0.650**	**0.762**						
Flexib.	0.337**	0.423**	0.581*	**0.838**					
DemUn.	0.298**	0.277*	0.223**	0.219**	NA				
Supdep.	0.334**	0.317**	0.332**	0.224**	0.218**	**0.846**			
Buydep.	0.286**	0.117	0.162*	0.176*	0.050	0.364**	**0.932**		
ExtUn.	0.197**	0.007	0.620	0.257**	-0.147*	0.079	0.051	NA	
PLC	0.097	0.075	0.084	0.152*	0.830	0.045	0.036	-0.012	NA

square root of AVE in diagonal for reflective constructs
** significant at the 0.01 level (2-tailed), * significant at the 0.05 level (2-tailed)
NA: Not applicable

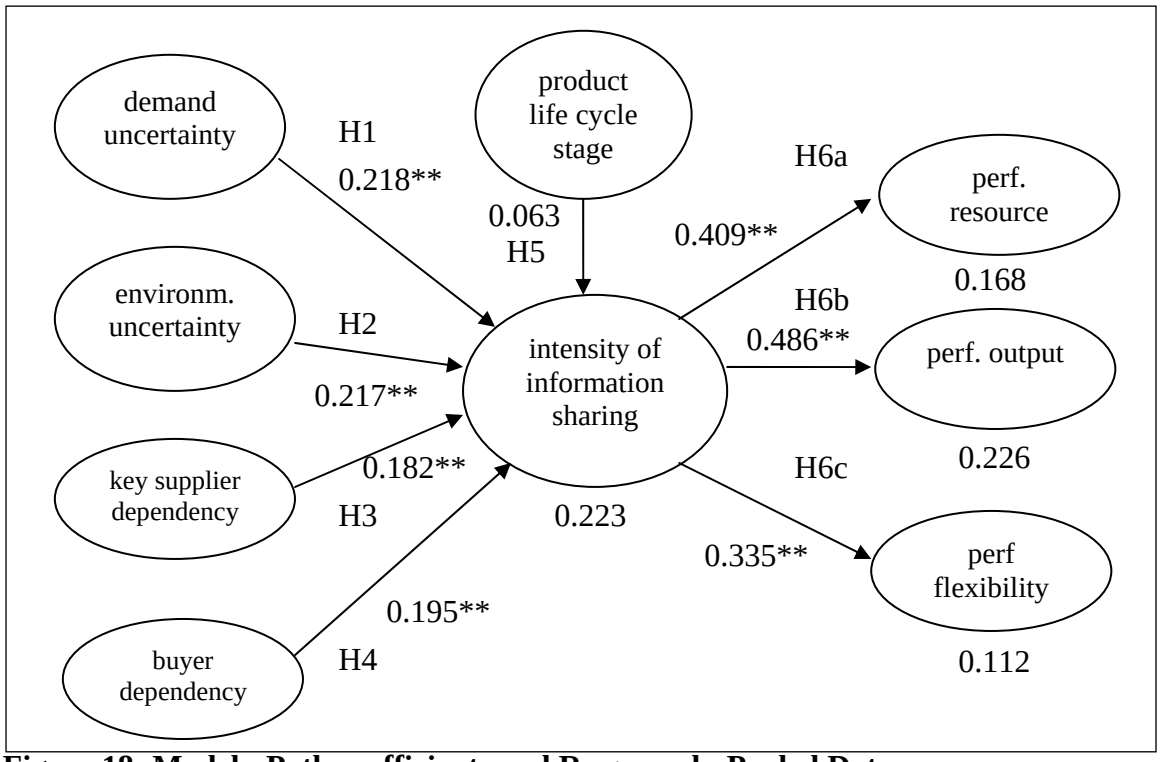

Figure 18: Model - Path coefficients and R squared - Pooled Data
** significant at p < 0.01, * significant at p < 0.05

6.5 Summary

An extensive analysis was carried out in this chapter using the data obtained from the survey. Finnish and Swedish data were first analyzed separately for the purpose of comparison and due to the potential for cultural differences. Respondent companies in both countries represented a large variety of manufacturing companies, and a high concentration on size and position was not found. The means of communication with key suppliers and the enabling software were found to be at an intermediate stage, the majority using EDI and ERP systems, if any.

The results of the PLS analysis (Finland and Sweden separately), which took the inputs from the factor analysis, supported the predicted hypotheses except for the relationship between PLC and information sharing. Because the results were consistent for the two samples the data was pooled, which again yielded similar results.

7 Discussion

7.1 A Review of the Study

The subject of this study was information sharing between buyers and key-suppliers, a topic that has received widespread attention from both academia and industry in the current IT era. Despite the popularity of the topic, the link between theory and practice has remained week in the literature. Previous research mainly focused on the benefits of information sharing but fell short in providing a more holistic view of the subject, which would include the tools, motivations, and drivers of information sharing. In the past, the topic has also suffered from conflicting theories and scarce empirical evidence, which called for further research into the subject.

In the light of the gap in the pertinent literature, this study set out to explore the factors that are likely to affect the level of information shared between buyers and their key suppliers. This was paramount to meeting the first objective of the study, which was to explain why certain firms choose to share more information with each other than with others. The second objective of the study was to identify the effects of information sharing on the focal firm - the buyer. For this purpose, a model that captured the determinants and consequences of information sharing was built using a contingency approach. The study investigated the phenomenon from the buyer's point of view and with an emphasis on the information systems used.

The theoretical underpinnings for the study were mainly derived from TCE as well as the RBV of the firm. According to TCE and RBV, firms must constantly evaluate their environment (the market, competitors, customers, suppliers, etc.) for opportunities that allow the preservation and creation of firm structures and resources, which in turn lead to competitive advantage. In this endeavor, a key factor that can affect the outcome and therefore the success of the firm is the level of uncertainty a company faces. A reduction of uncertainty can optimize decision-making within a company. Hence, theory suggests that it is in the interest of companies to share information with each other so as to reduce the highly critical demand uncertainty as well as uncertainty relating to a firm's

environment (environmental uncertainty). Thus, for the purpose of modeling information sharing between firms, uncertainty emerged as an important element that could potentially and to a degree explain companies' motivations to share information with each other. Further analysis of the literature and the application of TCE indicated that asset specific investments and switching costs, which can be regarded as dependency, could trigger information sharing. The reason for this is that dependency is a weakness against a powerful party and the weaker firm might want to engage in trust building activities such as information sharing to reduce the potential for opportunistic behavior. On the other hand, a more powerful party might be able to force the partner into sharing information. Hence, dependency on the exchange partner (supplier/buyer dependency) was identified as a further factor that might affect the level of transparency between firms. The model also took into account the risk of information sharing as access to private information can lead to opportunistic behavior or to spillovers. As a proxy for the criticality of the shared information and therefore risk, the product life cycle stage of the buyer was used. The effects of information sharing on performance were modeled using a three dimensional measurement representing resource, output, and flexibility measures.

A questionnaire was developed to test the model, which used pre-tested measurement instruments. The sample included the largest Finnish and Swedish manufacturing companies. Purchasing managers were targeted as respondents. A total of 2460 questionnaires were sent to companies (excluding returned mail) in February and in June 2006. Usable responses totaled 221 (Finland 119, Sweden 102). Extensive tests using PLS provided support for all the hypotheses in the model except for the association between the PLC of the buyer and the intensity of information shared. The results are summarized in Table 22.

Table 22: Summary of the results

Hypoth. Nr.	Hypothesis	Support
H1	Environmental uncertainty is positively related to the intensity of information shared with key suppliers.	Yes
H2	Demand uncertainty is positively related to the intensity of information shared with key suppliers.	Yes
H3	A key supplier's dependence on the buyer is positively related to the intensity of information shared with key supplier.	Yes
H4	A buyer's dependence on the key supplier is positively related to the intensity of information shared with the key supplier.	Yes
H5	The intensity of information shared with key suppliers is positively related to the product life cycle stage of the buyer.	No
H6a	The intensity of information shared with key suppliers is positively related to resource performance.	Yes
H6b	The intensity of information shared with key suppliers is positively related to output performance	Yes
H6c	The intensity of information shared with key suppliers is positively related to flexibility performance.	Yes

This research has extended previous studies (for example, Kulp, 2002; Bagchi and Skjoett-Larsen, 2002, 2005; Bagchi et al., 2007; Li and Lin, 2006, Zhou and Benton, 2007) that have investigated the determinants and consequences of information sharing with key suppliers. The study found support for the controversial relationship between uncertainty and information sharing in the context of buyers and key suppliers. This result was consistent with the theoretical framework of the thesis, which argued that companies strive at minimizing external uncertainty (i.e. demand and environmental uncertainties): a reduction in uncertainty enables better decision-making (e.g. capital budgeting, production) and therefore leads to higher productivity in a company, which was also confirmed by this study. According to the results, the level of external uncertainty drove information sharing in the supply chain, which can be viewed as an

uncertainty-reducing activity. This should not come as a surprise as companies act rationally and are interested in creating greater value and reducing non-value adding activities.

The study also found a positive relationship between dependency and information sharing, a relationship that was not tested before. Dependency was measured as a function of asset specificity and switching costs. Both dependency on the supplier, and, supplier's dependency on the buyer were found to be positively related to information sharing. This can be interpreted in two ways: as buyers become more dependent on their key suppliers, suppliers are able to demand more information from their buyers. It might also be the case that as buyers become more dependent on their suppliers, buyers are willing to "pay" for more information by, for example, financing the implementation of integrated information systems and by providing free consulting. These kinds of "gestures" however cannot guarantee the sharing of information, especially of a strategic nature. The same logic can also be applied to a supplier's dependency on the buyer. Powerful buyers can force smaller suppliers to act in their own interest, which might conflict with suppliers' interests. To give an example of extreme buyer power, Wal-Mart, the biggest retailer in the world, was in the position to demand from its suppliers to have all their supplied products tagged with Radio Frequency Identification (RFID). If this mandate was not met by a certain date, Wal-Mart threatened to abandon them. The reason for this mandate was that Wal-Mart saw RFID tags, which help track goods as they move along the supply chain, as an important cost reducing technology. The implementation of RFID was however seen to be too costly for some small suppliers.

The positive relationship between information sharing and the three performance measures were consistent with previous studies and the theoretical argumentation of this study. Information sharing, which reduces uncertainty, has an enhancing effect on a company's performance due to facilitating better decision-making and reducing transaction costs. The strongest relationship was found between information sharing and output in all three samples. This result was expected. Performance improvements such as customer satisfaction and on-time delivery are relatively swiftly achieved after the

introduction of a new scheme, whereas resource (or flexibility) improvements in, for example, personnel requirements and operational costs, might take longer and are also somewhat less obvious to all personnel. In some cases, the benefits of information sharing might take rather long, that is, when, for example, new capital budgeting decisions based on enhanced information availability are implemented.

Regarding whether the goals of the study have been met, the answer is yes, to a satisfactory degree. There are certain factors such as uncertainty and dependency (determinants) that can explain the level of information shared between a buyer and their key suppliers. Furthermore, information sharing allows for the improvement of operations leading to, for example, higher inventory turnover, product quality, and customer satisfaction (consequences).

This research has focused on information sharing (information integration) rather than more advanced forms of integration such as collaboration. Information sharing as such is interesting as it is the essential element in any kind of integration effort between two companies. Furthermore, information sharing is clearly a more common phenomenon than cooperation or collaboration, which are more advanced forms of integration. This was clearly an advantage for conducting research, as there is more data for common practices than occurrences of exception. For this study, it was also important to look at independent companies where ownerships differed. This is not always the case when companies have strategic partnerships. In such structures, partnering companies have joint facilities and/or assets, which lead to interdependence to some extent. This can be considered as a form of vertical integration, not qualifying the company as an independent company. Thus, for the purpose of this study, information sharing as such fit well with the motivation and the type of study conducted. However, this should not imply that other forms of integration efforts should not be of interest to a researcher. In contrast, such studies would contribute both to theory and to practice, especially when integration between companies is likely to increase in the future due to ever increasing competitive pressures.

7.2 Contribution

In a broader sense, the study has shed light on a popular and widely reported topic - integration between companies. Even though the study has investigated the most basic form of integration (information integration), information sharing is clearly a sine qua non in any kind of integration. Despite the popularity of the topic, empirical evidence in the field was highly scarce. Thus this study attempted to provide an explanation for the phenomenon. The first objective of the study was to find out whether integration efforts between companies could be attributed to certain factors, which would explain differences in integration choices. This was both interesting and important as integration between companies is generally regarded as positive and desirable. Also, emerging technologies such as RFID and various software solutions demand more interorganizational integration.

Results indicated that there are certain forces (the level of uncertainty and dependence) that drive integration between companies. If these factors are brought to the attention of company managers, they can be influenced to encourage more information sharing on for example production and promotions, which would then lead to greater performance. This study has also contributed to the wider in scope SCM literature, which attempts to manage the supply chain as a whole. Without understanding what factors bind companies together, it is impossible to demand that supply chains act as one entity.

A further contribution of the study was to confirm the value of information sharing (second objective), which has been a controversial subject in the literature. The study also showed that companies use a mixture of traditional and modern means to communicate with their key suppliers. This trend is likely to continue in the future. However, it would be economically unfeasible to integrate IT systems with every key supplier. Furthermore, when the relationship with a key supplier is relatively new, companies might want to use traditional means of communication. This subject is further explored in Section 7.6, Conclusions and Further Research.

Transaction cost economics provided a fruitful framework for analyzing information sharing practices between buyers and key suppliers. Hence, in the future, researchers can continue to use it as a theoretical lens with which to interpret phenomena in the era of e-commerce. In fact, what we observe in supply chains today is vertical integration to some extent without the transfer of ownership. Similar to Williamson (1991), Coad and Cullen (2006) refer to organizations that benefit from the synergies of vertical integration and maintain the efficiency of arm's length transactions as hybrids.

7.3 Limitations

As with every study, there are limitations in this study. The first limitation relates to the fact that data was only obtained from focal firms: the buyers. A better approach would have been to get data from both, buyers and key suppliers. This would have captured buyer supplier relationships more holistically and accurately, leading to possibly more insight and a smaller measurement error. However, practical considerations such as survey length and anonymity of respondents did not permit a different approach.

The second limitation relates to self-selection bias. This is the case when the respondent provides all the information for the entire questionnaire. In this study, the respondent was the purchasing manager. However, this is a common practice in survey research for several reasons. First of all, it is obviously easier to obtain responses from a single person rather than from two or more persons in a firm, especially in self-administered surveys. Furthermore, this type of design enables anonymity for the respondent and for his or her company. By providing subjective measures of, for example, company performance, the responses do not have to be matched with information from other sources such as a database. Furthermore, even if this was done, the links between the factors of interest and aggregate performance measures that are typically stored in databases (e.g. ROI, profit margin) are hard to establish. Hence specific performance measures such as those used in this study are more likely to capture cause and affect relationships between variables when compared to aggregate measures. Another

limitation that relates to the above discussion is concerned with how well one person from a company can provide the answers to all the questions in a survey.

A further limitation of the study relates to a possible deficiency of the risk measure regarding information sharing, a likely explanation for the insignificance of the relevant hypothesis. It might have been better to focus on information sharing at different stages of a company's PLC. This was done in Wagner (2003). The measure used in this study was perhaps too general.

7.4 Validity and Reliability of the Study

As with any study, the results of this study have to be interpreted with caution. One must address the internal and external validity of a study. Internal validity refers to the rigor with which a study was conducted. Furthermore, when causal relationships are explored in a study, internal validity also refers to the extent to which the designer of the study has taken into account alternative explanations for the causal relationships explored. External validity relates to the degree to which results are generalizable or transferable. There is a high degree of generalizability when results and conclusions from a study can be applied to a population larger than the population represented by the sample. Results are said to be transferable when they can be applied to a similar context and when the reader can link the elements of the study with one's own experiences.

To ensure a high level of internal validity, the concepts of the study were carefully defined prior to their use. The critical concepts of the study such as information sharing, collaboration, and uncertainty were used and applied within the same context. Construct validity, a measure for how well the instrument measures the concept in question, was ensured using previously tested measures. In general, the measures performed well. Furthermore, the validity of the proposed cause and effect relationships (the hypotheses) of the study were carefully assessed and the possibilities for alternative relationships, i.e. opposite signs for hypotheses were considered.

The sample for the study included two countries: Finland and Sweden. The fact that two countries were included in the sample has clearly a favorable impact on generalizability, despite the fact that the countries are geographically (and culturally) very near. Also, the fact that the two countries were first analyzed separately and that results were fairly similar supports the generalizability of the results. Furthermore, this study did not include any cultural elements specifically; hence there should be some scope for generalizability. Therefore, it can be argued that similar results would be obtained from the rest of Europe, and probably from North America.

Regarding reliability, the nature of the method of the study ensures replication. The questionnaire was well documented as well as the tools used for analyzing the hypothesized relationships. Hence, replication will very likely produce similar results for a similar sample. This was also confirmed by the separate analysis of the two countries.

A problem that has been recently raised in theory-based management accounting research relates to the endogeneity problem (Chenhall and Moers, 2007). The problem arises when the explanatory variable correlates with the error term of the explained variable. This is the case when there is an omitted variable that is affecting both the explained and explanatory variable. Hence the exogenous variable becomes an endogenous variable whose value is determined within the model. A further cause for endogeneity is when there is simultaneity: a situation where the explanatory variable is jointly determined with the explained variable. Hence, the causality in this case is in both directions. Chenhall and Moers (2007) argue that no theory-based empirical study is free from this problem. Since this problem has implications for the validity of the results, it is worthwhile to consider the possible occurrence of this problem in this study. Whereas the inclusion of a number of other factors such as relationship length and trust in the model might have increased the explanatory power of the model, this was unlikely to be a source for endogeneity in the sense discussed above. Hence, an evaluation of the model suggested that the possibility and magnitude of omitted

variables and simultaneity were minimal and that they were unlikely to have an invalidating effect on the results.

7.5 Managerial Implications

In the 21st century, businesses have to act rapidly. Competitive pressures are on the rise and uncertainty is part of the game. This means that companies have to constantly make critical business decisions such as in which future capabilities to invest as well as what and how much to produce. Sound decision making requires access to timely and accurate information. For this purpose, companies can turn to their supply chain partners for valuable information and knowledge regarding for example, forecasts, trends, and developments in the industry. Thus, effective communication between exchange partners will reduce costs (including transaction costs) and supply chain risk, as well as create mutual trust. So, practitioners might want to reconsider the importance of working more closely with their exchange partners in order to maintain and improve their businesses. Furthermore, information sharing between supply chain partners is a relatively easy and cost-effective solution against uncertainty when compared to alternatives such as adding buffers, flexibility, and capacity to production.

Information sharing or collaboration requires a fundamental step: the communication of its advantages to the exchange partner(s) in question. This requires an initiator, who can be either the exchange partner or a third party such as a consultant. Given that the involved parties understand the potential for mutual benefit (although their magnitude might differ), the companies are likely to engage in information sharing. For example, if order variability is a problem, the companies could begin to collaborate by sharing demand forecast data, what today, many companies already do. Once the companies begin to realize the benefits (e.g. through smaller order variance) of information sharing, more advanced forms of collaboration can follow, i.e. the implementation of one or several supply chain practices discussed in Chapter 3. Moreover, collaboration will become even more effective when similar initiatives are carried out at different

exchange points along the chain, gradually leading to supply chain management in a true sense.

However, information- and process integration are likely to create interdependencies (e.g. as a result of dedicated IT systems or relying too much on one key supplier), which companies need to take into account. Furthermore, the sharing of critical company information might carry the risk of opportunism or information spill-over. However, as long as companies do not rush into blindly adopting the supply chain solutions promoted, a one step at a time approach will minimize the risk.

7.6 Conclusions and Further Research

To reduce uncertainty and benefit from improved information flow, firms need to engage more with their key suppliers (although the results of this study can also be extended to key customers). For this purpose, companies could create cross-company teams that would evaluate integration possibilities. Given that a cost-benefit analysis warrants integration, companies could then work out the extent and form of integration (e.g. VMI, CPFR, etc.), which might depend on priorities and strategies of firms (e.g. product availability vs. lean manufacturing).

As explored in this study, there are different means of information sharing: traditional and advanced methods. It might be better to first share information using the simpler traditional methods such as e-mails or telephone. This would avoid costly investments and over commitment at the outset, thus minimizing sunk costs should the initiative fail. The use of more traditional modes of communication (e.g. face to face) in the beginning would also allow the parties to get to know each other and build trust. If after a trial period benefits are obtained, companies could then move on to consider the exact workings of integration. In some cases, it might be worthwhile to integrate the specific ERP modules so as to provide close to real-time information to the other partner. In other cases, it might be more reasonable to integrate using only traditional methods. Overcoming the technical barriers to integration might be difficult as systems are not

always compatible. The use of XML and the development of taxonomies (for automatic data identification) to automate information flow would certainly be useful.

This study has shown that information sharing can reduce uncertainty and risk, which could well be a decisive factor for attaining competitive advantage. Hence companies need to incorporate the idea of the extended supply chain into their long-term strategy. Competencies must be developed to deploy such a strategy, which might in turn require developing capabilities in logistics and management accounting (for performance evaluation). Companies could make use of consultants in order to manage change but caution must be taken as consultants' interests might not always fully agree with that of the contractor.

The drawback of any kind of integration is that it might create a dependency between firms, as switching costs and asset specific investments are likely to increase with more involvement. However, information integration will lead to the least dependency between companies compared to process integration. Nevertheless, apart from the benefits of information sharing, the "costs" in terms of opportunistic behavior and possible spillovers need to be considered as well. If the risk is too big, contracts must be developed and monitoring mechanisms need to be put into place to minimize the exposure to risk. Hence, it must be emphasized again that companies must perform a cost–benefit analysis prior to engaging in information sharing activities, especially with non-trusted key-suppliers.

Once the benefits of information sharing transpire, how can partners share them? This does not seem to be a problem as in supply chain management. In a dyadic setting such as this, the partners can provide information based on the reciprocity principle as laid out in social capital theory (Blau, 1964). As long as firms reciprocate by providing equally useful information and by not acting opportunistically, the exchange relationship will continue. In cases where information flow is one-way, when, for example, a retailer provides demand information to its key supplier, as the retailer would have no use of supplier information, the supplier would have to reward the retailer differently, for example, through premium prices. In new relationships, the

principle of reciprocity can be applied incrementally; resulting in the build up of trust over time when reciprocity is sustained.

In principle, opportunistic behavior will be punished by both the exchange partner and by the market in the form of a loss of image and sales. As partners are trusted, companies can be certified as trusted parties (similar to an ISO certification – trust instead of quality). Such recognitions can increase trust between firms and accelerate the process of information integration and beyond.

A possible avenue for research would be to investigate the long run affects of information sharing and integration for the supply chain structure and price levels. Sustained close relationships might lead to vertical integration between firms, which can limit competition. Also, this new trend might lead to companies competing on the basis of the fitness for integration instead of solely the price. Hence companies will not only be evaluated according to what they can supply or buy today but as a potential partner for the future where companies thrive together through sharing, learning, and improving.

Clearly, there are many research possibilities in this field. It almost naturally follows that a replication study could be done for a different geographical region such as the United States, Brazil, or China. Results can then be compared to the Nordic region, which would allow for the identification of any differences between organizational cultures and diffusion of communication technologies. Also, more research can be done on other factors that might influence information sharing between companies and perhaps factors that are moderating this relationship. This would complement theory and thus lead to a better understanding of the topic. For example, a factor of interest to research might be absorptive capacity: “the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends” (Cohen and Levinthal, 1990). Absorptive capacity might mediate the relationship between information sharing and performance.

Having confirmed that transaction cost theory can be used as a lens to view interorganizational information sharing, it might be interesting to look at more specific types of practices: for example, interorganizational cost management. However such practices are relatively uncommon. Thus, multiple case studies might be more appropriate for this kind of research. In addition, longitudinal studies would provide insight into the practices of firms, identifying the factors that shape decisions within firms. To this purpose, other lenses could also be used. One potential lens is the old institutional economics, which focuses upon processes rather than outcomes. Hence, the use of multiple lenses can mitigate the shortcomings of different theories.

More practitioner-oriented research could be valuable too. For example, how can a cost – benefit analysis be carried out for the purpose of integration? How can the risk of opportunism be quantified versus benefits of integration? This would help firms make more efficient and effective choices when evaluating integration opportunities with other firms.

The relative value of intangible assets, which are largely not accounted for (unless purchased) by the accounting system have been increasing with respect to tangible assets, which determine the book value of a company. This is evident from the increasing gap between stock and book values (price-to-book ratio) of companies. Given that investors value human resources (e.g. competencies) and social capital (e.g. relationships with supply chain partners), it might be fruitful to research the means to include such assets in the financial statements of companies. After all, it is not the assets that create value, but the way they are utilized.

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Appendices

Appendix 1: The Questionnaire

1. Please circle your position in the supply chain.		
a) Raw Material Manufacturer	b) Component Manufacturer	c) Final Product Manufacturer
d) Wholesale/distributor	e) Retailer	f) Other: ……

2. Please circle the industry group you are in.	
a) Automotive	b) Materials (chemicals, metals, paper, etc.)
c) Capital Goods (building, machinery)	d) Consumer Durables & Apparel (household, leisure)
e) Retailing (multiline retail)	f) Retailing (food & staples)
g) Food and Beverages	h) Household & Personal Products
i) Health Care Equipment	j) Pharmaceuticals and Biotechnology
k) Technology Hardware & Equipment (including semiconductors)	l) Other: …….

3. Please provide the following information about your company.
a) What were your company's approximate annual sales in Swedish Krones in 2005? -------million kr.
b) About how many different products does your company sell? -------
c) What is the percentage of your company's key suppliers over total suppliers? -------%
d) What is your company's approximate return on invested capital (ROI)? -------%

4. How much information does your company provide to its key suppliers? *-please circle your response for each-*	**none**			**some**			**a lot**
a) We give our key suppliers demand forecast information.	1	2	3	4	5	6	7
b) We give our key suppliers customer information (e.g. point of sales data).	1	2	3	4	5	6	7
c) We give our key suppliers inventory level information.	1	2	3	4	5	6	7
d) We give our key suppliers promotion/campaign information.	1	2	3	4	5	6	7
e) We give our key suppliers access to our warehouse/transportation management system.	1	2	3	4	5	6	7
f) We give our key suppliers product design plans.(if applicable)	1	2	3	4	5	6	7
g) We give our key suppliers R&D information/plans.	1	2	3	4	5	6	7
h) We give our key suppliers production plan information.(if applicable)	1	2	3	4	5	6	7
i) We give our key suppliers production capacity information. (if applicable)	1	2	3	4	5	6	7

5. What kind of information systems do you use to exchange information with your key suppliers? *-please circle all that apply-*	
a) Enterprise Resource Planning	b) Private Web Portals
c) Electronic Data Interchange	d) Supplier Relationship Management Software
e) Other: …….	

6. Please indicate if you are using any of the below supply chain <u>practices</u> to collaborate with your key suppliers? *-please circle all that apply-*

a) Collaborative Planning, Forecasting and Replenishment
b) Supply Chain Planning
c) Vendor Managed Inventory
d) Advanced Planning and Scheduling
e) Other……

7. How would you estimate your company's performance <u>improvement</u> after providing company information (demand forecasts, inventory, R&D plans, etc.) to your key suppliers?
-please circle all that apply-

	no						**extensive**
a) Inventory turnover	1	2	3	4	5	6	7
b) Equipment utilization	1	2	3	4	5	6	7
c) Energy use	1	2	3	4	5	6	7
d) Operational costs	1	2	3	4	5	6	7
e) Stock out costs	1	2	3	4	5	6	7
f) Personnel requirements	1	2	3	4	5	6	7
g) Fill rates	1	2	3	4	5	6	7
h) On-time delivery	1	2	3	4	5	6	7
i) Flexibility to deliver	1	2	3	4	5	6	7
j) Product quality	1	2	3	4	5	6	7
k) Documentation quality	1	2	3	4	5	6	7
l) Product variety	1	2	3	4	5	6	7
m) New product introductions	1	2	3	4	5	6	7
n) Customer satisfaction	1	2	3	4	5	6	7

8. Please indicate how dependent your key suppliers are on your company by expressing your opinion on the following statements.

	disagree						**agree**
a) Our key suppliers will incur high costs (lost sales) if we switch to a new supplier.	1	2	3	4	5	6	7
b) Our key suppliers will incur high costs in human effort (searching) if we switch to a new supplier.	1	2	3	4	5	6	7
c) Our key suppliers have made specific investments into machinery or procedures to supply the products.	1	2	3	4	5	6	7

9. Please indicate how much you agree with the following statements.
-please circle your response for each-

		disagree						**agree**
a)	Our company has a high rate of new product introductions.	1	2	3	4	5	6	7
b)	It is hard to predict product demand.	1	2	3	4	5	6	7
c)	Our company's products have short life cycle times.	1	2	3	4	5	6	7
d)	Our company has a large product variety.	1	2	3	4	5	6	7
e)	Our company has a large number of sales channels.(if applicable)	1	2	3	4	5	6	7
f)	Our company's products have a long product to market cycle times.	1	2	3	4	5	6	7
g)	Received orders are made very frequently.	1	2	3	4	5	6	7
h)	Changes in order content are very frequent.	1	2	3	4	5	6	7
i)	Orders are expedited frequently causing changes in order processing and production schedules.	1	2	3	4	5	6	7
j)	The lead times of our company's products are long.	1	2	3	4	5	6	7

10. Please indicate how dependent your company is on your key suppliers by expressing your opinion on the following statements.

	disagree						**agree**
a) Our company will incur high costs (e.g. searching, contracting) if we switch to a new supplier.	1	2	3	4	5	6	7
b) Our company will incur high costs (e.g. searching, contracting) in **human effort** if we switch to a new supplier.	1	2	3	4	5	6	7
c) Our company has made specific investments into machinery or procedures to process the purchased product.	1	2	3	4	5	6	7

11. What is the information sharing policy between your company and its key suppliers?
-please circle your response for each-

	disagree						**agree**
a) We share our business units' proprietary information with suppliers.	1	2	3	4	5	6	7
b) We inform key suppliers in advance of changing needs.	1	2	3	4	5	6	7
c) Our key suppliers share proprietary information with us.	1	2	3	4	5	6	7
d) Our key suppliers keep us fully informed about issues that affect our business.	1	2	3	4	5	6	7
e) Our key suppliers share business knowledge of core business processes with us.	1	2	3	4	5	6	7
f) We and our key suppliers exchange information that helps establishment of business planning.	1	2	3	4	5	6	7
g) We and our key suppliers keep each other informed about events or changes that may affect the other partners	1	2	3	4	5	6	7
h) How large is the strategic risk (loss of business opportunities) for your company. **small** in providing information on its business to its partners?	1	2	3	4	5	6	**large** 7

12. Would your company consider to share more information (more detail and scope) with it's key suppliers in the future?

a) yes b) no

13. Please indicate the level of external environmental uncertainty for your company.

	predictable						**unpredictable**
a) Supplier's actions (prior collaboration)	1	2	3	4	5	6	7
b) Customer demands, tastes and preferences	1	2	3	4	5	6	7
c) Deregulation and globalization	1	2	3	4	5	6	7
d) Market activities of competitors	1	2	3	4	5	6	7
e) Production and information technologies	1	2	3	4	5	6	7
f) Government regulation and policies	1	2	3	4	5	6	7
g) Economic environment	1	2	3	4	5	6	7
h) Industrial relations	1	2	3	4	5	6	7

14. Given below are descriptions of four alternative stages of the product life cycle. Considering all the products of your firm, please indicate below the percentage of products that are at the following stages.

a) Emerging (a new product has recently been launched on the market: currently sales are low and prices are relatively high) --------%

b) Growth (a product that has increasing sales due to increasing demand) --------%

c) Mature (a product that provides stable income, neither increasing or declining sales while prices remain low) --------%

d) Declining (profits and sales are declining due to declining interest by consumers) --------%

100%

15. If there is something you wish to add or comment on, please do so in the box below.

Comments:

Thank you very much!

Appendix 2

Factor Analysis – Performance – Confirmatory - Finland

Factors	Loading	Variance	Cronbach's Alpha	Item Mean	Stand. Dev.
Resource Measures		49%	0.813		
energy use	0.756			2.43	1.29
equipment utilization	0.736			3.47	1.48
operational costs	0.734			4.30	1.36
inventory turnover	0.662			4.58	1.47
personnel requirem.	0.584			3.19	1.55
Output Measures		56%	0.841		
on-time delivery	0.901			5.10	1.49
customer satisfaction	0.869			4.92	1.56
fill rates	0.780			4.15	1.68
stock-out costs	0.710			5.02	1.45
product quality	0.339			3.84	1.63
Flexibility Measures		50%	0.723		
new product introd.	0.897			3.89	1.68
product variety	0.687			3.53	1.68
flexibility to deliver	0.475			5.18	1.37

Factor Analysis – Demand Uncertainty - Finland

Pattern Matrix(a)

	Factor		
	1	2	3
produncert1	.834		
produncert4	.577		
produncert3	.530		
produncert5	.385		
produncert7	.383	.321	-.381
produncert9		.761	
produncert8		.721	
produncert6			.558
produncert10			.454
produncert2			

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

Appendix 3: Correlations

Correlation Matrix for Upstream Information Sharing - Finland

		inf1	inf2	inf3	inf4	inf5	inf6	inf7	inf8	inf9
Correl.	inf1	1.000	.338	.440	.410	.190	.532	.424	.473	.388
	inf2	.338	1.000	.332	.289	.209	.204	.393	.206	.278
	inf3	.440	.332	1.000	.518	.372	.495	.337	.404	.386
	inf4	.410	.289	.518	1.000	.323	.329	.228	.228	.249
	inf5	.190	.209	.372	.323	1.000	.288	.162	.206	.167
	inf6	.532	.204	.495	.329	.288	1.000	.563	.584	.421
	inf7	.424	.393	.337	.228	.162	.563	1.000	.549	.608
	inf8	.473	.206	.404	.228	.206	.584	.549	1.000	.708
	inf9	.388	.278	.386	.249	.167	.421	.608	.708	1.000

Correlation Matrix for Performance - Finland

		perf1	perf2	perf3	perf4	perf5	perf6	perf7	perf8	perf9	perf10	perf12	perf13	perf14
Correl.	perf1	1.000	.442	.453	.589	.494	.376	.510	.524	.458	.286	.212	.348	.509
	perf2	.442	1.000	.654	.498	.528	.409	.575	.521	.376	.338	.372	.417	.557
	perf3	.453	.654	1.000	.492	.452	.452	.495	.439	.378	.386	.242	.272	.450
	perf4	.589	.498	.492	1.000	.579	.447	.559	.624	.559	.239	.209	.297	.582
	perf5	.494	.528	.452	.579	1.000	.350	.547	.657	.582	.173	.236	.344	.630
	perf6	.376	.409	.452	.447	.350	1.000	.627	.458	.453	.323	.414	.469	.458
	perf7	.510	.575	.495	.559	.547	.627	1.000	.705	.525	.326	.488	.467	.656
	perf8	.524	.521	.439	.624	.657	.458	.705	1.000	.763	.275	.405	.529	.779
	perf9	.458	.376	.378	.559	.582	.453	.525	.763	1.000	.209	.325	.427	.593
	perf10	.286	.338	.386	.239	.173	.323	.326	.275	.209	1.000	.295	.308	.326
	perf12	.212	.372	.242	.209	.236	.414	.488	.405	.325	.295	1.000	.617	.439
	perf13	.348	.417	.272	.297	.344	.469	.467	.529	.427	.308	.617	1.000	.502
	perf14	.509	.557	.450	.582	.630	.458	.656	.779	.593	.326	.439	.502	1.000

Correlation Matrix for Demand Uncertainty - Finland

	uncert1	uncert2	uncert3	uncert4	uncert5	uncert6	uncert7	uncert8	uncert9	uncert10
uncert1	1.000	.231	.442	.462	.300	.236	.304	.178	.133	.080
uncert2	.231	1.000	.119	.298	.128	.188	.135	.276	.242	.241
uncert3	.442	.119	1.000	.268	.232	.127	.274	.147	.175	.080
uncert4	.462	.298	.268	1.000	.271	.139	.244	.214	.074	.162
uncert5	.300	.128	.232	.271	1.000	.054	.126	.155	.153	-.022
uncert6	.236	.188	.127	.139	.054	1.000	-.148	.145	.052	.260
uncert7	.304	.135	.274	.244	.126	-.148	1.000	.285	.284	-.041
uncert8	.178	.276	.147	.214	.155	.145	.285	1.000	.555	.224
uncert9	.133	.242	.175	.074	.153	.052	.284	.555	1.000	.181
uncert10	.080	.241	.080	.162	-.022	.260	-.041	.224	.181	1.000

Correlation Matrix for Information Sharing - Finland

		sharing1	sharing2	sharing3	sharing4	sharing5	sharing6	sharing7
Correlation	sharing1	1.000	.495	.637	.411	.590	.415	.379
	sharing2	.495	1.000	.417	.428	.463	.372	.684
	sharing3	.637	.417	1.000	.522	.530	.378	.428
	sharing4	.411	.428	.522	1.000	.642	.430	.459
	sharing5	.590	.463	.530	.642	1.000	.534	.506
	sharing6	.415	.372	.378	.430	.534	1.000	.598
	sharing7	.379	.684	.428	.459	.506	.598	1.000

Correlation Matrix for Environmental Uncertainty -Finland

	envrnuncert1	envrnuncert2	envrnuncert3	envrnuncert4	envrnuncert5	envrnuncert6	envrnuncert7	envrnuncert8
envrnuncert1	1.000	.000	-.069	-.094	.058	.176	.157	.235
envrnuncert2	.000	1.000	.232	.343	.244	.112	.098	.086
envrnuncert3	-.069	.232	1.000	.240	.247	.011	.234	.304
envrnuncert4	-.094	.343	.240	1.000	.403	.039	.256	.228
envrnuncert5	.058	.244	.247	.403	1.000	.185	.098	.279
envrnuncert6	.176	.112	.011	.039	.185	1.000	.304	.278
envrnuncert7	.157	.098	.234	.256	.098	.304	1.000	.499
envrnuncert8	.235	.086	.304	.228	.279	.278	.499	1.000

Appendix 4: Path Coefficients

Model – Finland (T-statistics)

	InfoSha.	Resou.	Output	Flexib.	DemUn.	Supdep.	Buydep.	ExtUn.	PLC
InfoSha.	0	0	0	0	3.9595	2.1431	2.9244	3.154	0.5794
Resou.	7.9926	0	0	0	0	0	0	0	0
Output	10.0784	0	0	0	0	0	0	0	0
Flexib.	5.0297	0	0	0	0	0	0	0	0
DemUn.	0	0	0	0	0	0	0	0	0
Supdep.	0	0	0	0	0	0	0	0	0
Buydep.	0	0	0	0	0	0	0	0	0
ExtUn	0	0	0	0	0	0	0	0	0
PLC	0	0	0	0	0	0	0	0	0

The Outer Model - Finland

Factors	**l/(w)**	**AVE**	**Comp. Rel.**
Demand Uncertainty		NA	NA
rate of product introductions	(0.107)		
product demand	(-0.131)		
short life cycle times	(0.413)		
large product variety	(0.245)		
sales channels	(-0.024)		
product to market cycle time	(-0.602)		
frequent orders	(-0.255)		
changes in order content	(0.424)		
orders expedited frequently	(0.363)		
lead times of products	(0.283)		
Environm. Uncertainty		NA	NA
supplier's actions	(0.024)		
customer demands	(-0.121)		
deregulation and globalalizat.	(-0.276)		
competitors	(-0.062)		
production and IT	(0.396)		
government regulation	(0.877)		
economic environment	(0.054)		
industrial relations	(-0.138)		
Supplier Dependency		0.735	0.893
lost sales	0.894		
searching effort	0.883		
asset specific investments	0.791		
Buyer Dependency		0.899	0.947
monetary cost	0.947		
effort	0.950		
Product Life Cycle			
Intensity of Information Sharing		0.564	0.900
proprietary (1)	0.745		
needs	0.730		
proprietary (2)	0.738		
informed	0.726		

processes	0.806		
planning	0.727		
events	0.779		
Perform. resource		0.628	0.832
equipment utilization	0.874		
energy use	0.852		
product quality	0.627		
Perform. output		0.627	0.921
inventory turnover	0.683		
operational costs	0.793		
stock-out costs	0.763		
fill rates	0.766		
on-time delivery	0.898		
flexibility to deliver	0.777		
customer satisfaction	0.833		
Perform. flexibility		0.642	0.843
personnel requirements	0.772		
product variety	0.826		
new product introductions	0.805		

NA: Not applicable

Model – Sweden (T-statistics)

	InfoSha.	Flexib.	Output	Resource	DemUn.	Supdep.	Buydep.	ExtUn.	PLC
InfoSha.	0	0	0	0	3.747	2.0611	2.3465	2.7627	1.4328
Flexib.	3.2002	0	0	0	0	0	0	0	0
Output	4.2898	0	0	0	0	0	0	0	0
Resource	3.5608	0	0	0	0	0	0	0	0
DemUn.	0	0	0	0	0	0	0	0	0
Supdep.	0	0	0	0	0	0	0	0	0
Buydep.	0	0	0	0	0	0	0	0	0
ExtUn.	0	0	0	0	0	0	0	0	0
PLC	0	0	0	0	0	0	0	0	0

The Outer Model - Sweden

Factors	**l/(w)**	**AVE**	**Comp. Rel.**
Demand Uncertainty		NA	NA
rate of product introductions	(0.641)		
product demand	(-0.080)		
short life cycle times	(-0.353)		
large product variety	(0.381)		
sales channels	(0.207)		
product to market cycle time	(0.257)		
frequent orders	(0.001)		
changes in order content	(0.173)		
orders expedited frequently	(-0.030)		
lead times of products	(-0.012)		
Environm. Uncertainty		NA	NA
supplier's actions	(-0.941)		
customer demands	(0.380)		
deregulation and globalalizat.	(-0.020)		

competitors	(0.126)		
production and IT	(0.027)		
government regulation	(0.184)		
economic environment	(0.497)		
industrial relations	(-0.155)		
Supplier Dependency		0.899	0.947
lost sales	0.933		
searching effort	0.963		
asset specific invest.*			
Buyer Dependency		0.669	0.857
monetary cost	0.854		
effort	0.909		
asset specific invest.	0.671		
Information Sharing		0.573	0.904
proprietary (1)	0.699		
needs	0.766		
proprietary (2)	0.755		
informed	0.808		
processes	0.687		
planning	0.824		
events	0.751		
Perform Resource		0.710	0.880
energy use	0.810		
oper. costs	0.868		
equipm. utiliz.	0.848		
Perform Output		0.572	0.888
On-time del.	0.835		
flex. to del.	0.809		
cust. satisf.	0.825		
fill rates	0.779		
inv. turnover	0.656		
stock-out costs	0.603		
pers. requirem.*			
Perform Flexibility		0.790	0.919
prod. variety	0.911		
new prod. intro.	0.912		
prod. quality	0.842		

* discarded as it loaded 0.598 in PLS
NA: Not applicable

Pooled Data (T-statistics)

	InfoSha.	Resource	Output	Flexibil.	DemUn	Supdep.	Buydep.	ExtUn.	PLC
InfoSha.	0	0	0	0	3.5417	2.739	3.1727	3.8577	1.0275
Resource	7.3201	0	0	0	0	0	0	0	0
Output	8.2524	0	0	0	0	0	0	0	0
Flexibil.	5.1524	0	0	0	0	0	0	0	0
DemUn.	0	0	0	0	0	0	0	0	0
Supdep	0	0	0	0	0	0	0	0	0
Buydep	0	0	0	0	0	0	0	0	0
ExtUn.	0	0	0	0	0	0	0	0	0
PLC	0	0	0	0	0	0	0	0	0

The Outer Model – Pooled data

Factors	](w)	AVE	Comp. Rel.
Demand Uncertainty		NA	NA
rate of product introductions	(0.484)		
product demand	(-0.067)		
short life cycle times	(-0.024)		
large product variety	(0.347)		
sales channels	(0.075)		
product to market cycle time	(-0.088)		
frequent orders	(0.051)		
changes in order content	(0.389)		
orders expedited frequently	(0.223)		
lead times of products	(0.086)		
Environm. Uncertainty		NA	NA
supplier's actions	(-0.378)		
customer demands	(0.105)		
deregulation and globalalizat.	(-0.260)		
competitors	(-0.078)		
production and IT	(0.324)		
government regulation	(0.847)		
economic environment	(0.242)		
industrial relations	(0.300)		
Supplier Dependency		0.716	0.882
lost sales	0.913		
searching effort	0.912		
asset specific invest.	0.693		
Buyer Dependency		0.869	0.930
monetary cost	0.919		
effort	0.944		
Information Sharing		0.562	0.900
proprietary (1)	0.728		
needs	0.743		
proprietary (2)	0.747		
informed	0.761		
processes	0.742		
planning	0.763		
events	0.760		
Perform Resource		0.602	0.857
equipment utilization	0.805		
energy use	0.806		
operational costs	0.797		
personnel requirements	0.686		
Perform Output		0.582	0.906
customer satisfaction	0.821		
stock out costs	0.716		
inventory turnover	0.675		
fill rates	0.758		
on time delivery	0.849		
flexibility to deliver	0.784		
Perform Flexibility		0.703	0.876
product variety	0.875		
new product introductions	0.870		
product quality	0.764		

NA: Not applicable